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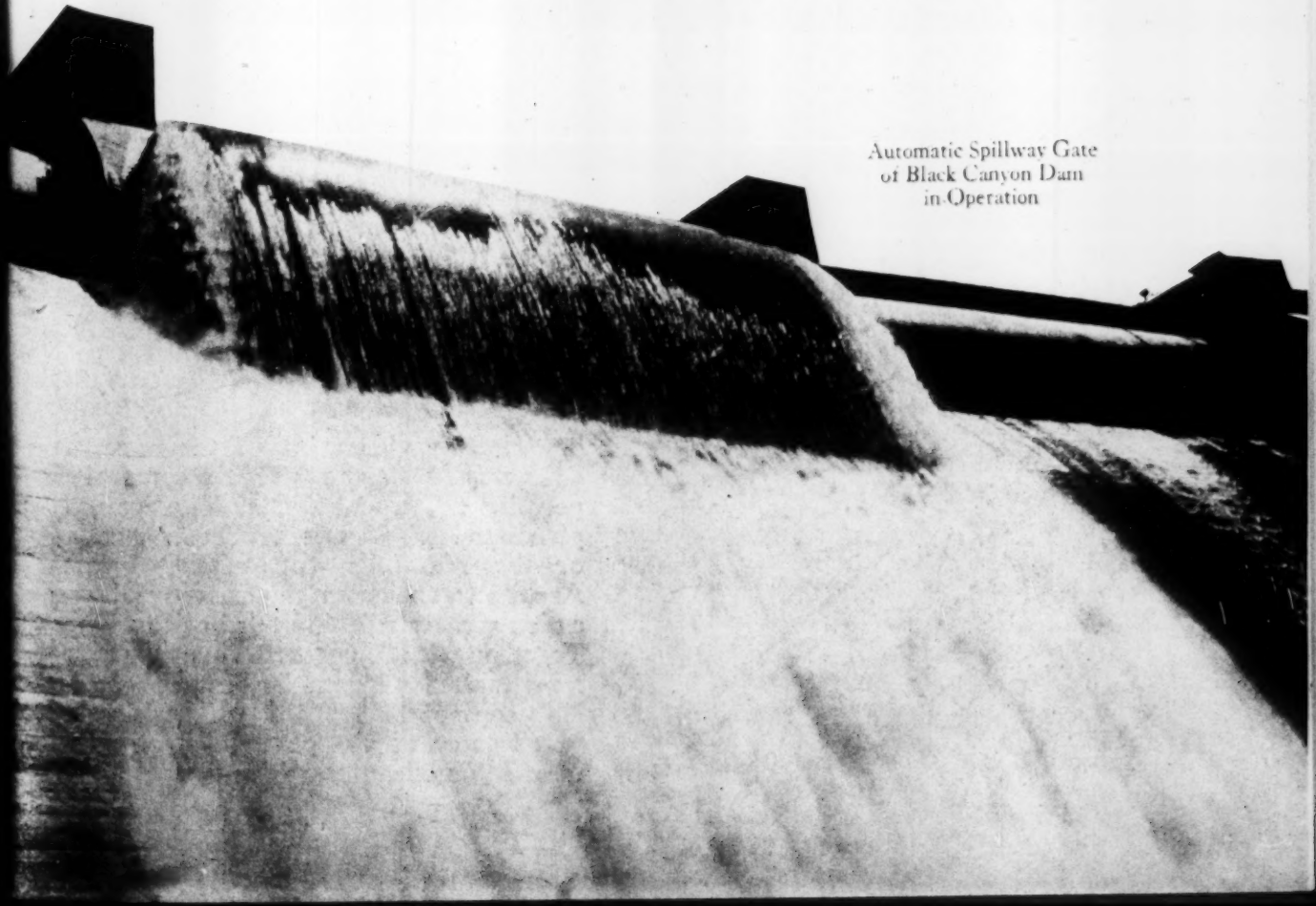
Automatic Spillway Gates of Black Canyon Dam

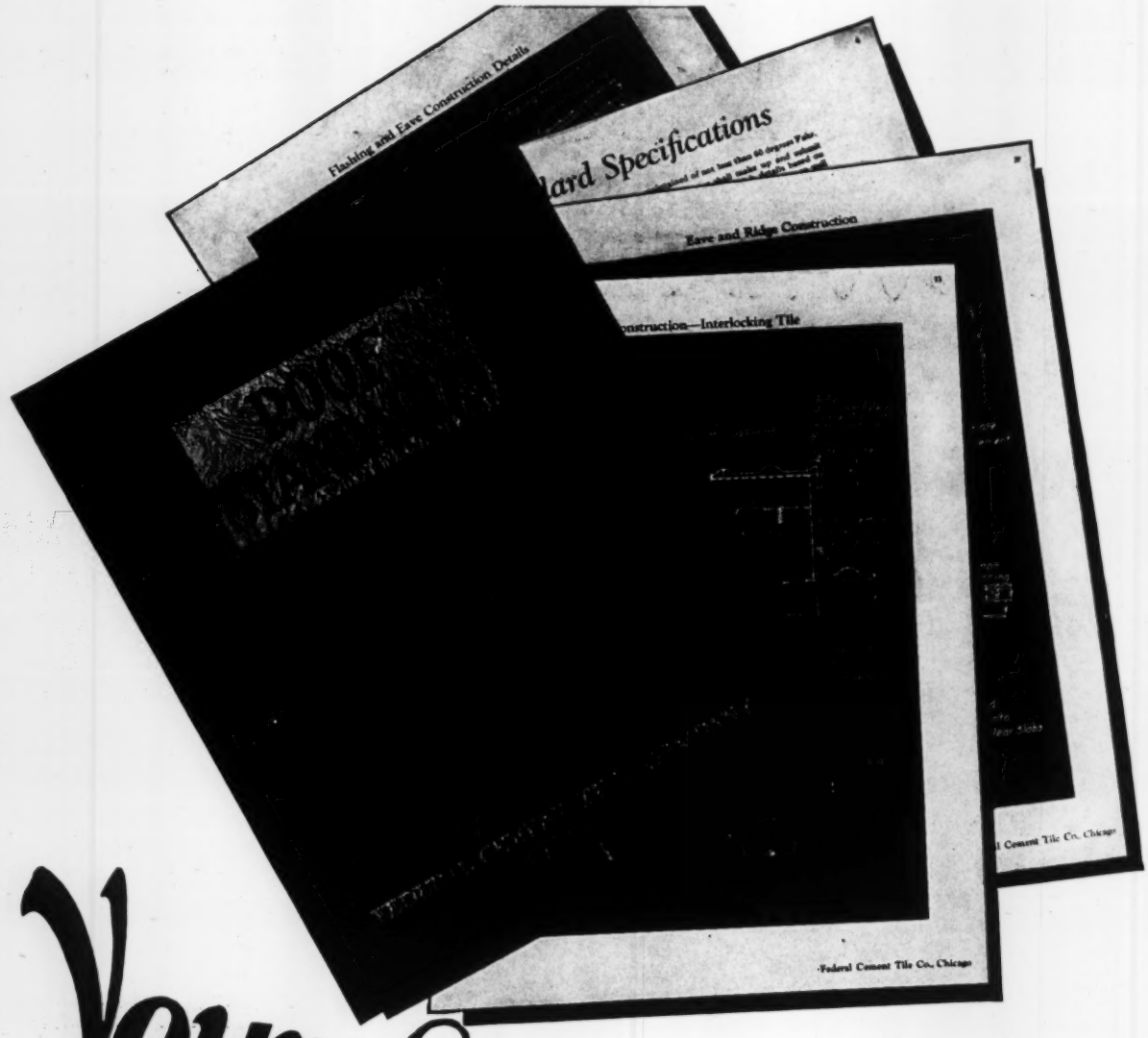
Tests of Bond Resistance on Reinforced-Concrete Beams

Design Considerations in Dix River Rock-Fill Dam

A Building for Industrial Research and Testing Work



Automatic Spillway Gate of Black Canyon Dam in Operation



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ENGINEERING NEWS-RECORD

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WIGHT
Editor

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Interstate Power Control

SECRETARY HOOVER'S argument against federal control of power, made to the N. E. L. A. at San Francisco last week, was timely and impressive. Political philosophy today is setting against further extension of federal authority; the states are coming back into their own. But the amazing extension of electrical service and the difficulties that arise when the political barrier of a state boundary interferes with the freedom of that extension have led many to believe the only solution of government control lies in Washington. Mr. Hoover, in his customary role of advocate of less government in business, points out the dangers of such a move, but he emphasizes, too, the excellent service that the states have done in controlling power utilities and commends to the states the possibilities of co-operation in the continuance of such control. Interstate arrangements for the control of overlapping power lines have already made some progress but they must be encouraged, not only by the people but also by the power companies, for in such co-operation lies the only relief from a future federal control.

Engineering Museum Going Forward

PROSPECTS for the early success of the movement for an engineering museum are measurably brightened by the enlistment of Samuel Insull. His well known capacity for large affairs and the confidence that he will inspire among prospective benefactors make the museum much more of a possibility than it has hitherto been. The meeting the other day, noted in our news columns, was well attended by some of the leaders in engineering and industry and by representatives of the major engineering societies. Their interest is now assured. With a stable organization and the backing of engineers it may well be hoped that the museums, both the main one at Washington and the local units at New York, Pittsburgh and Chicago, will in fair time be available as inspiration and education to the engineer.

Economy in Dam Design

A STATEMENT of the conditions and reasons back of the development of the design of the Dix dam is given in this issue. The just completed structure, it will be recalled, is the largest rock-fill dam ever built, and compares well in size with the largest dams of any type. It also is significant as representing the introduction into Eastern practice of this peculiarly Western type. Besides the great height, the steep slopes of the dam and the nature of its water-side protection are most noteworthy. It is to be remembered in considering these features that the dam was designed under great pressure for economy. The funds available for the enterprise were limited, and everything possible had to be done to attain lowest cost. Fortunate local conditions made it readily possible to obtain a spillway capacity so much beyond prospective needs that the safety of the dam against overtopping seems absolutely assured. Inasmuch as rock-fill dams have never failed by percolation or bodily washout, but only by the wash occurring in overflow, the safety and permanence of the dam may be taken for granted. It is somewhat more of a question whether the concrete watertight membrane placed on the freshly dumped fill will adapt itself to the settlement of the embankment without cracking. Where the supply of water is only enough for the expected demand, as here, the loss of water in case cracks of serious proportions should develop may easily prove critical so far as financial results are concerned. There is only a small amount of available experience to guide in designing such a membrane and judging of its performance, however, and much may be learned from the service results at the Dix dam for the benefit of future construction of similar works.

An Argument Gone

THE Chicago Sanitary District has for some time been contending that the Niagara Falls power interests did not have clean hands in complaining about Chicago's excess use of lake water. That line of attack is demolished by the report just issued by officials of the Canadian and the United States governments who report that the treaty limitations of use of Niagara water have not been exceeded on either side of the line. So this "you're another" kind of argument, never a very impressive one for an important city to take, is denied Chicago.

Seasonal Repairs

SEASONAL employment is as largely a problem of distributing building repairs as of spreading construction over twelve months instead of six months. Indeed, today in most large cities construction shows fewer seasonal peaks than do repairs and renovating. Owners of rentable property are notoriously in the habit of bunching their arrangements for new tenants into a month or two of the fall and spring renting seasons. So also do owners who close their city houses in summer and their country places in winter and postpone putting either in order until a few weeks before changing residence from one to the other. Indeed the whole practice of building repairs, painting, decorating, alterations and general renovation is highly seasonal due solely to habit and custom. The result is overtime work and prices, less efficient workmen and rushed jobs. The owner pays. Just how much more he pays is difficult to tell but it is enough to profit him highly by doing June repair work instead of September repair work. Building Congresses which are battling for a twelve-month distribution of repair work deserve the full support of engineers and contractors.

Arterial Road Costs

MODERN highway costs reach their peak in the construction of arterial highways through great metropolitan districts. An example is the arterial road west from the Holland tunnel as described in the issue of April 30. According to tentative estimates this 22-mile road will cost some $30,000,000. Its construction, however, involves several expensive tunnels, depressed roads and viaducts not normally a condition of arterial road development. A more normal example is the Great West Road just opened for London traffic to and from the west counties of England. It is 8½ miles long and cost £1,150,000 or virtually $720,000 a mile. There were no special structures comparable with the tunnels and viaducts of the Holland tunnel road. Instead the money went for straightforward road-building and land acquirement for a 115-ft. right of way with a 50-ft. asphalt on concrete pavement, two parkways and two foot walks. These two roads by no means include all the examples worthy of mention but they are works accomplished or in progress and they perhaps mark the range in costs—$750,000 to $1,500,000 a mile—which confront the arterial road builder. These are astounding figures to contemplate.

Two Cities Reject Manager Plan

GENERAL apathy on both sides played a great part in the recent defeat of the city manager plan at both Yonkers and Schenectady, N. Y. Half of the registered voters stayed away from the polls in each city; but the two-to-one negative vote was decisive enough in each case. Inertia, which is general apathy in another form, accounts for many of the adverse votes; or conservatism, if that term is preferred. Among the more positive forces in the two defeats may be counted the more or less professional politicians, who rarely like to see a change of this sort, and those to whom ward representation seems the only "American" way. The latter are slow to see that representation of areas is far less significant than that of policies or principles and that the latter can best be secured by proportional representation. Besides the election-at-large bogey, another one is said to have played a part; at least in Yonkers, where the old plea was advanced that the city manager plan may work in small places but not in one of a hundred thousand population or more. Some of these people have not heard or will not remember that Dayton has had a city manager for years; Cleveland for 18 months; and that Cincinnati recently voted for the manager plan. The effect of the Yonkers and Schenectady defeats on the movement for the adoption of the manager plan at Rochester, N. Y., will be looked for with interest. Latest accounts indicate that a proposal to provide for proportional representation at Rochester was finally negatived, which is perhaps a wise decision, especially as it can be voted on later and separately if desired.

Wanted: A Drive for Highway Safety

THE census of automobile fatalities in our cities for 1924 has just been issued by the government. It is far from hopeful. Accidents are increasing in nearly every city, not only in number but per capita. That they are decreasing in number per automobiles in use is not the important thing the automobile people try to make it out to be. The figures show that so far, at least, the campaign for highway safety has not begun to make itself felt, unless possibly it has served to retard what would otherwise have been an increasing acceleration of accidents. But it is hardly possible that the new movements for highway safety can fail soon to impress themselves. The campaign is fast growing. Especially should the impetus of the Hoover conference held at Washington last December begin soon to be felt. That conference was the first of what promises to be a series of meetings which will serve each year as the culmination of a great deal of concentrated work by experts. Already has next December's conference organized and the committees which are to report then are hard at work studying not so much how highway safety can be assured in an ideal community but how those principles which are known to conduce to safety can be successfully and practically applied. The conference seeks now to find things that will work and to find ways to make them work. And it is being backed up by consistent publicity and by regional and local meetings similar to the ones at Washington. The statistics just issued show that more work and more intensive work is needed. Every one should help.

Progress in Filtration

PERIODICALLY in the development of the art of any particular field a summing up of the progress is essential. Such a summary of a detail in the field of filtration of water is presented in the symposium elsewhere in this issue on the status of a particular type of underdrain. A wooden grating made of 1-in. boards laid on edge and separated by spacers of equal thickness is the type under discussion. Out of the difficulties from the blowing-up of the sand bed that this type presented at Sacramento came the use of a cemented-gravel layer used to hold the gravel in place. Cemented-gravel is European, Canadian and South American practice, not much used in the United States.

Some difference of opinion yet exists as to the merits, usefulness and necessary precautions essential to successful use of the slat-bottom underdrain. Its simplicity and low cost make it an alluring proposition for, as Wellington Donaldson says, it puts underdrain construction into the hands of carpenters. J. W. Armstrong, who proposed the type, has had one full-sized unit in successful operation for more than a year and has under construction additional filters using this design. J. W. Kelsey of St. Paul reported success with the system. A thick gravel layer 16 to 18 in., is one of the essentials apparently. Those who report failure have used thin layers. Opponents of the system adhere to the old theory on which the major number of underdrains are designed that an even distribution of wash water under the gravel layer must be obtained by material reduction of head through orifices of some kind, usually in metal. The deep gravel layer performs this service in the slat-bottom underdrain.

More light is needed on certain points but enough limitations are given to let future experimenters start without repeating the failures already made. Since Chicago is now seriously considering filtration, it is fitting that she should bear her share of the burden of experimental costs and establish a testing station for just such problems thus in turn adding her technical contribution to the long line of solutions of filter problems that other cities have made available for her use.

Get the Facts on Force Account

SOME weeks ago in Washington the Associated General Contractors launched a major drive against the doing of public work by force account, concentrating their attack upon the Corps of Engineers. Unfortunately, for an unprejudiced consideration of the case, the local press was used as the forum for a debate between the contractors and the Corps, and both sides, through the medium of interviews, resorted to the legal method of charging the opponent with a variety of crimes, not with any idea that they were all existent but in the hope of making some one of them stick. The resulting impression of the controversy was so confused that those who are honestly interested in getting some real light on the problem of public force account work would do better to disregard this current exhibition altogether.

Nevertheless, there is here a problem which engineers must consider. The ultimate end of all engineering is construction, the building or replacing of something of use or convenience. Approximately six billion dollars went into such construction in the United States last year, no inconsiderable part of the annual contribution to permanent wealth. Much of this is done for the people through their separate governments and a growing percentage of this government work is being carried out without the medium of contractors. How best to get that work completed at a minimum of cost is as much the duty of the engineer as it is his duty to guarantee the safety and sufficiency of the completed work.

If economy and security can be insured better by the government engineer acting as entrepreneur, undertaking not only design and inspection, but also the hiring of the labor, the purchasing of the material and the supervision of the construction itself, then it is time that the accepted contract system be discarded. But that system has the stamp of approval of time. It should not be discarded, or undermined insidiously by slow degrees, without full knowledge of how the proposed substitute is operating and toward what it ultimately tends. This calls for an examination of facts, which having been ascertained can be applied to test the validity of the argument that at present is for the most part a mere mental exercise.

In such mental exercise there is no denying the superior claims of the contract system. The arguments for it have been often recorded and need not be repeated here. They are so sound that even those who prosecute or advocate force account on special jobs are quick to protest their dislike for it as a general practice. But the special jobs fast multiply when construction organizations are built up and equipment is amassed and the exception soon becomes the rule. How economical do these operations really prove? Is the work actually cheaper, taking all things into consideration? Does it tend to reduce the number of contractors? Do engineering organizations doing construction become fossilized when safe from competition as to construction costs? These are some of the things that should be particularized.

The contractors are trying to get at those facts, but they are hampered on the one side by their inability to get from government bodies doing force account work a complete cost account and on the other by their own prejudice which unfortunately colors their comparative analyses and leads them into such fallacies as the comparison of the actual cost of the completed work with a preliminary estimate based on the engineer's design. Government bodies doing force account work for their part have done little toward justifying such activity, other than to present on specific operations figures that are most difficult of analysis and, in the case of some representatives of the Corps of Engineers, making ridiculous charges as to the motives of the contractors who are activating the drive against force account work. Calling names is not argument.

To get at the truth between those two is a difficult task. The investigator must disregard some of the common assumptions. He must hold to the criterion that the public has the right to have its construction work done at the lowest cost, but he must also remember that such lowest cost is not measured by the cost of a specific job but by the long time operation of a construction system. He must deny the inherent right of the contractor to existence but he must realize that experience has shown that bureaucratic or political control becomes inefficient and expensive. He must maintain that even communism cannot be successfully attacked merely by saying that it is communism but only by showing wherein communism is inefficient.

How can such an investigation be prosecuted? There is no hope of a complete investigation that will settle the question once and for all. This is not that kind of a problem. But it can be furthered by separate investigations by unbiased parties. Congress might do it for the federal departments, but Congressional investigations have not of late recommended themselves as trustworthy. Some of the investigatory branches of the executive, such as the Department of Commerce or the Federal Trade Commission, could do the job were it not for the so-called inter-departmental courtesy that forbids one bureau or department at Washington meddling in the affairs of another. Similar disabilities lie in any governmental investigation in state or city.

There are, too, our economic foundations and our technical societies. For them the opportunity is manifest and should be seized. By so doing they can render a great service to the construction industry and to the community. Doubtless the contractors have overemphasized the dangers in the increase of force account work. Taking it altogether it is still only a small proportion of the total construction work of the country. But it is increasing and the concern regarding the increase is warranted. The American Society of Civil Engineers, the National Industrial Conference Board or the Chamber of Commerce of the United States might any one of them well start an independent study of force account work and gather together some of the facts that are sadly lacking to those who would like to be able to judge fairly of its justification.

Meanwhile, since none of these agencies has seen fit to inaugurate such a study, this journal will undertake one of its own. During the coming summer a fact-finding campaign into the workings of specific force-account operations will be prosecuted by *Engineering News-Record*. No prejudices will govern this study and no preconceived notions will flavor its findings. It will be an honest effort to illuminate a dark land. We hope before winter comes to have contributed some basic data to this disputed subject.

Automatic Spillway Gates of Black Canyon Dam

Special Requirements Leading to Decision to Install Crest Gates of Drum Type Operated by Variations in Water Level—Details of Construction and Operating Results

By Julian Hinds
Assistant Designing Engineer, Bureau of Reclamation, Denver, Colo.

RECENTLY the U. S. Bureau of Reclamation completed and put into operation a power and diversion dam across the Payette River on the Boise irrigation project, Idaho, known as the Black Canyon dam (described in *Engineering News-Record*, Nov. 20, 1924, p. 818). Automatic spillway gates of drum type are installed on this dam, and these invite special consideration.

Reasons for Use—The purpose of the dam is to deliver water by pumping to the north side main canal of the Emmet Irrigation District, develop electric power, and (eventually) deliver water by gravity to the main canal of the Black Canyon division of the Boise reclamation project of the Bureau of Reclamation. The height to which the water above the dam may be raised is limited by the tracks of the Idaho Northern R.R., but, on the other hand, in order to meet the power and diversion requirements it is essential that the normal water surface in the river above the dam be held at the highest permissible level at all times. Flood waters must therefore be passed with practically no increase in water level. These conditions require some type of movable spillway crest.

Prompt and accurate adjustment of the crest to the varying flow of the river is essential. It is also necessary that the control shall not be subject to serious interruption by ice flows or by floating logs or trees. These considerations led to the selection of the drum type of crest gates, similar to the gates used for the spillway from the Arrowrock reservoir, on the same project, but with an automatic controlling device. While gates of this type are not uncommon, the Black Canyon installation is worthy of note because of the size of the gates, their curved upstream face, and the automatic control.

A good idea of the spillway may be had from the views Figs. 1 and 2 herewith. The three notches (Fig. 1) are each 64 ft. wide; the drum gates have a net lift of 14 ft. 6 in. They are placed on the line of the original river channel. The computed maximum spillway discharge with a water surface elevation of 2,497 ft. is approximately 40,000 sec.-ft. An appreciably larger flow can be passed for a short period without damage to the dam, although serious encroachment on the railroad grade is not permissible. A greater flood than 40,000 sec.-ft. is not expected.

General Gate Arrangement—The arrangement of the spillway section of the dam is shown in Fig. 3. Fig. 4 shows an enlarged section through the crest of the dam. The essential features of the drum gate and its fastenings are shown on Fig. 5. Each gate is a hollow prism, 64 ft. long, with one plane and two curved sides. The ends are closed and all joints are calked to make them watertight. Each gate operates in a drum chamber in the top of the dam, attachment being made by a cast-steel hinge at the upper upstream corner of the chamber.

The gate is raised and lowered by filling and emptying the drum chamber. Rubber seals along the downstream edge of the chamber and at the ends of the gate minimize leakage. Two sets of seals are required at the ends, one along the edge of the upstream face plate and one along the downstream face plate. Finished cast-iron plates set into the faces of the piers (Fig. 4) provide smooth surfaces against which the end seals slide. The downstream seal is housed in an iron seat casting, a section of which is shown in Fig. 5. These

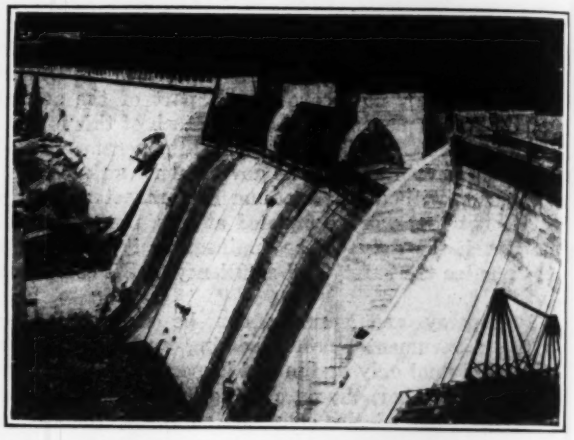


FIG. 1—BLACK CANYON DRUM GATES DURING ERECTION

castings are made in 4-ft. lengths, bolted together and anchored into the concrete. One seat casting at each end and one at the center of each gate are provided with a removable top to facilitate the replacement of the rubber seal. Excessive leakage at the hinges is prevented by holding to the smallest permissible clearance between the hinge parts and between the hinge casting and the 10x¾-in. cover plate on the anchorages. The bolt holes in the cover plate are slotted to facilitate adjustment.

Flow into the drum chamber for each gate is controlled separately by a 2.4x3-ft. slide gate set on the center line of one of the piers. The outflow is controlled normally by a 24-in. balanced valve, interconnected with the automatic control system. A separate outlet, closed by a 16-in. gate valve, is provided for auxiliary use. All hand controls, except the auxiliary gate valve, are located on top of the piers, where the operator has a full view of the spillway. The arrangement of the primary controls is shown in Fig. 6. The position of the 16-in. auxiliary valve is shown in Fig. 3. All outlet valves discharge into a 4x5-ft. tunnel running parallel to the axis of the dam, with outlet and air vent at each end of the spillway. Leakage into each drum is removed by two armored drain hose leading from the ends of the drum to a cast-iron drain pipe at the center of the drum chamber. This pipe connects with the discharge tunnel from the outlet valves.

A gallery or passageway through the dam, with con-

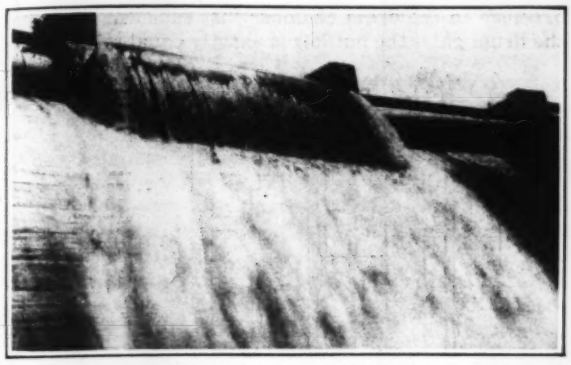


FIG. 2—MIDDLE GATE AT BLACK CANYON IN OPERATION

necting stairways, affords ready access to the operating equipment and to the tops of the piers. Each drum chamber is connected with the operating gallery by a manhole.

Gate Design—The Black Canyon drum gates depart from previous designs for like structures in that the upstream or top face is curved. It is thought that this curvature will improve the hydraulics of the spillway, and stabilize the pressures acting on the drum in partially raised positions.

The curved frame angles act both as beams and struts, and the stresses are more or less uncertain. The uncertainty is increased by the eccentricity of the hinge pins and by doubt as to the pressures to which the gate will be subjected. Neither the reaction of the overflowing jet of water, nor the magnitude of the frictional forces is known. In cases of doubt, parts were designed to take any stresses which might reasonably be assumed to come upon them.

It is necessary that the downstream face be smooth and accurately curved in order that the rubber sealing device may function properly. All rivets in this face were countersunk and tolerance in the radius of the face was limited to ¼ in. plus or minus. The manufacturers claim to have found this tolerance difficult to maintain.

Automatic Control — Each of the three gates is equipped with an automatic control, designed to maintain a fixed relation between the position of the gate and the quantity of water flowing over it. The assembled mechanism of one of these controls is shown in Fig. 6. When, due to an increase in flow, the water begins to overtop a gate, the gate must immediately start down, and must be stopped when it has reached a depth sufficient to permit the passage of the increased flow. This result is accomplished by placing the outlet valve under the control of both the drum gate and the water level above the dam. With the type of control used at Black Canyon, it is necessary that a definite variation in water level be permitted between no overflow and full discharge. A variation of 6 in. was assumed to be permissible.

Fig. 7 is a diagrammatic elevation of the control mechanism. The drum gate is indicated by dotted lines in the raised position and all other parts are shown in the positions they will occupy when the water is on the point of overtopping the crest.

Water for overcoming leakage from the drum chamber and for sustaining the drum gate in its raised position enters through the partially opened hand-operated inlet gate, *A*. This gate is permanently set at the smallest opening which can safely be depended on to maintain the required pressure in the drum chamber, against leakage, with the outlet valve closed. The drum gate is lowered by opening the balanced valve, *E*, and allowing the water to escape from the drum chamber, through the passages B and C. It is not necessary that the inlet gate be closed.

The outlet valves used at Black Canyon are 24 in. in diameter and have a 12-in. stroke. The type was developed originally for use as a bypass control for waterwheels. The valve is operated by the pressure of the water passing through it. The pressure in the chamber *E*, around the needle, is transmitted to the space *U* above the piston *J* through a restricted opening in the bypass pipe *G*. If there is no outlet from the chamber *U*, the pressure intensity on top of the piston will equal that on the bottom. The area exposed

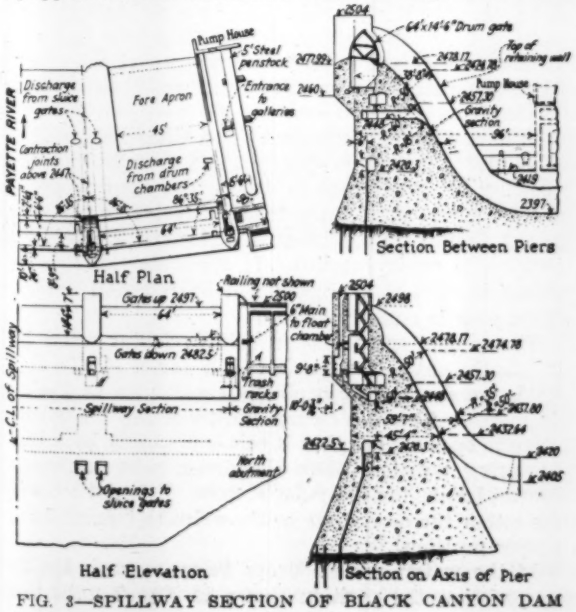


FIG. 3—SPILLWAY SECTION OF BLACK CANYON DAM

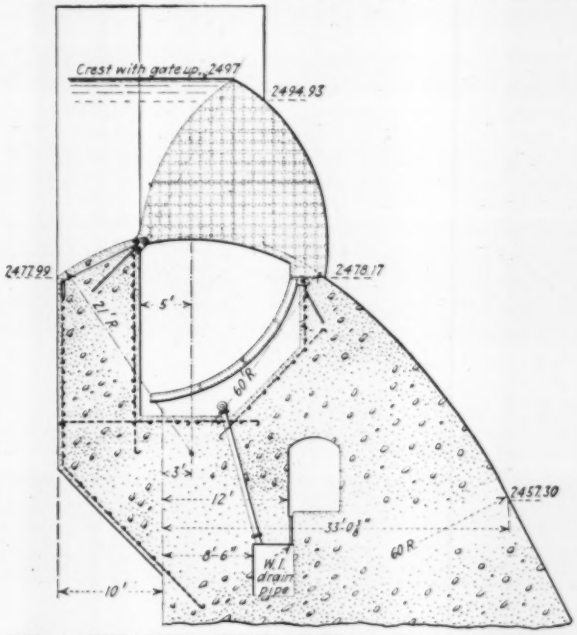


FIG. 4—ENLARGED CREST SECTION (GATE REMOVED)

to pressure on the top being greater than on the bottom, the needle will be pressed against its seat. If the water is permitted to escape from the chamber *U* through an opening relatively larger than the opening in the bypass pipe, the pressure on top of the piston will drop and the needle will be lifted from its seat by the excess pressure on the exposed part of the bottom of the piston. The outflow from the chamber *U* is controlled through the ports *D* and the pilot valve *F*.

How the Control Acts—Starting with conditions as shown in Fig. 1, let the water surface be assumed to rise slowly. The well around the float *H* communicates with the reservoir through a passage leading to a point beyond the influence of the draw-down curve at the spillway crest. The water level in the float well is always the same as in the river above the dam. If the float is properly adjusted, it will be on the point of rising, with conditions as shown, and will start up with the rising water level. The motion of the float is communicated through the bracket *R* and the sheave rod *V* to the floating sheave *K*, where it is doubled and transmitted to the pilot valve *F* through the bronze tiller rope. When the pilot valve is lifted a short distance the outflow from the chamber *U* exceeds the inflow, the pressure drops and the piston and needle rise. The sleeve rod S is thus lifted until it approaches the pilot valve. Outflow from the chamber *U* is thus checked, pressure builds up above the piston and the needle stops. As the float continues to rise the pilot valve is

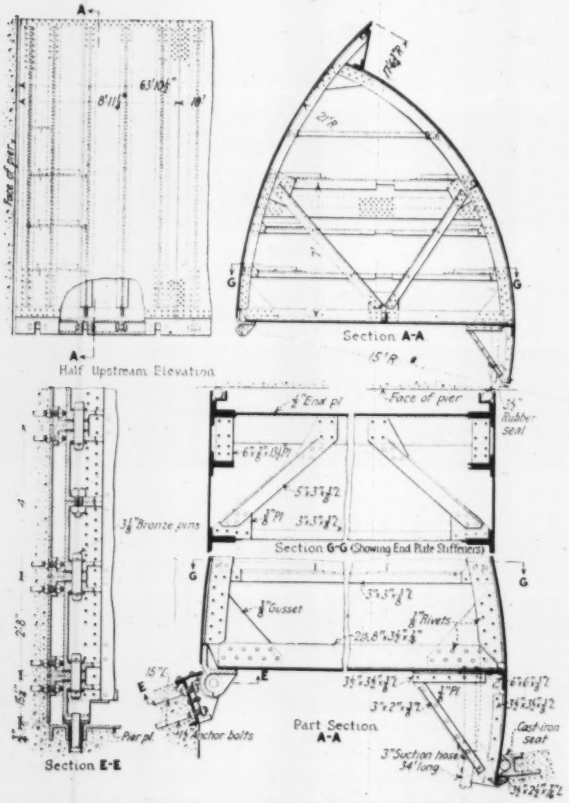


FIG. 5—DETAILS OF 14½ x 64-FT. DRUM GATE

gradually lifted higher, followed at all times by the needle of the balanced valve.

The first small movement of the balanced-valve needle will have no effect on the position of the drum gate, but will only increase the inflow through the gate *A*. When the balanced valve opening becomes such that with a pressure in the drum chamber just sufficient to support the drum gate, the outflow is exactly equal to the inflow,

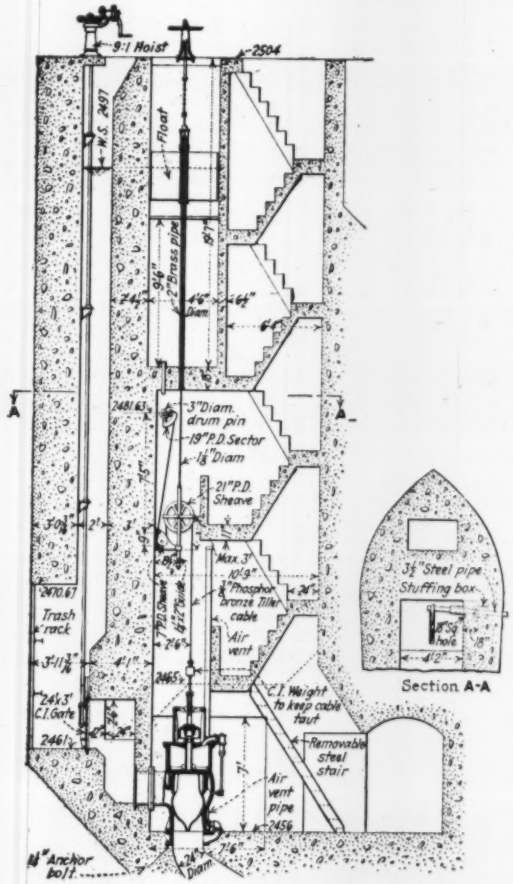


FIG. 6—ARRANGEMENT OF OPERATING MACHINERY

it is in a position which may be called the balancing position. If the water surface continues to rise after this condition is reached, the balanced-valve opening is temporarily increased. As a result, the outflow exceeds the inflow, the pressure in the drum chamber drops and the drum gate starts down. The bronze tiller rope after passing over the floating sheave *K*, passes under the fixed sheave *L*, and is anchored to the sheave sector *M*. The sheave sector is keyed to an extension of the hinge of the drum gate and moves with the drum gate. As soon as the drum gates start down tiller rope paid out at *M* passes under the sheave *L* and over the sheave *K*, allowing the pilot valve to drop. The opening process is thus reversed, and the balanced valve forced down, as the drum gate continues to fall, until the balancing position is again reached. If the water surface continues to rise, this process will be repeated until the drum gate is entirely down.

The cycle of operation for a slowly falling water level is exactly opposite that described for a slowly rising level, the drum gate gradually coming up as the flow decreases. A sudden change in flow causes the balanced valve to open rapidly, but it comes promptly back to the balancing position when the drum gate reaches the correct height for the changed flow. It is not necessary for either the drum gate or the valve to "hunt" for the proper position.

If the water surface drops below normal, the float drops below the position shown in Fig. 7 until it en-

counters some obstruction placed purposely to stop it. Such a movement would ordinarily tend to slack the bronze tiller cable and allow it to kink. This is avoided by a slip joint connection to the valve and a cast-iron weight at the end of the tiller rope, as shown in Figs. 6 and 7. In case of an unprecedented flood the water surface might continue to rise after the drum gate is completely down. The stroke of the pilot valve is somewhat greater than that of the balanced valve. This excess stroke, added to the float movement necessary to fully open the balanced valve, from its balancing position, permits the water level to rise about 12 in. above the theoretical maximum before all play in the system is taken up. In case of a further rise, the float will be held submerged. All parts are amply strong to withstand the resulting strains.

The balancing position of the 24-in. valve need not be computed in advance. It is controlled by the leakage into and out of the drum chamber, by the opening of the inlet gate *A*, and by the coefficient of discharge for the valves. In fact, this position is not constant, but will change from time to time as the condition of the sealing devices and the setting of the inlet gate change. The opening for the balancing position is relatively small and variations are unimportant. After the equipment is in place, proper adjustment is secured by changing the length of the sheave rod *V* or of the bronze tiller rope.

A handwheel hoist, *W*, on top of the pier, flexibly

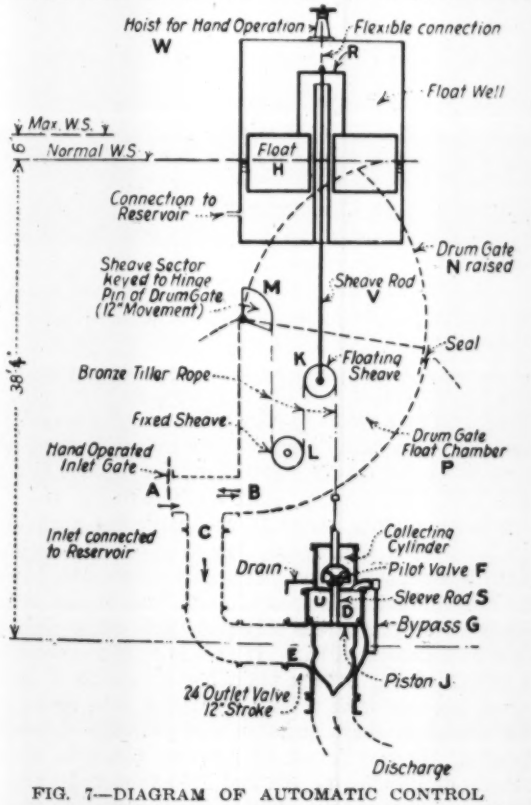


FIG. 7—DIAGRAM OF AUTOMATIC CONTROL

connected to the sheave rod may be used for lowering the drum gate by hand. Lifting the sheave rod with this hoist has the same effect as a rising of the water surface. The flexible connection permits free automatic operation when the handwheel hoist is down.

It should be noted that all parts controlled by the float are free-moving. No stuffing boxes or other parts likely to cause appreciable friction are used. The float was very carefully made, all joints being welded, and it is expected that it will be watertight. However, provision is made for the connection of a drain hose at some future time should leakage develop.

The various elements in Fig. 7 can readily be identified on Fig. 6, where they are shown to actual scale. The passage between the control gates and the drum chamber, corresponding to the passage *B* in Fig. 7 is shown dotted in Fig. 6. The method of connecting the sheave sector *M* to the drum gate is shown in Figs. 5 and 6. It will be noted that the 24-in. balanced valve is air vented a short distance below its seat.

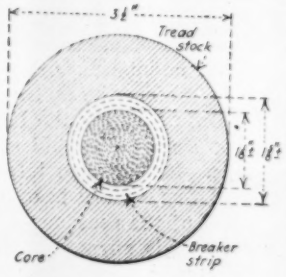


FIG. 8—RUBBER SEAL

Rubber Seals — On spillway gates of the drum type previously installed, leakage from the drum chamber is controlled by metal devices. It is necessary that the metal seals be made in short lengths to permit adjustment to the irregularities of the face plate. There is always a small leakage at each of the joints between sections of the seal. Ordinarily this leakage is of no importance, but at Black Canyon the gates will be in operation throughout the entire year and any small leak will cause objectionable formation of ice in the winter. For that reason an unbroken seal was considered desirable, and the rubber device shown on the drawings was adopted. This seal is water-tight, except for a small leak at each end of the drum gate, due to imperfect connection between the front and end seals. An additional advantage of this type over the usual metal type of seal is that it prevents flow into as well as out of the drum chamber. This is not important at Black Canyon but is advantageous in installations where the drum gate is subject to submergence by the tail water.

Because the Black Canyon sealing device is new, a detailed section of it is shown in Fig. 8. The section and specifications for the seal were adopted after experimentation in the laboratories of the Gates Rubber Co. of Denver. Hollow rolls, solid rubber rolls and rolls with steel cable cores were considered and discarded. The section adopted proved to be very satisfactory from a manufacturing point of view.

Seal Specifications—The specifications are as follows:

Core. The core shall be made of 13.3-oz. Karded Peeler cord fabric, the breaking strength of each cord to be not less than 15 lb., frictioned two sides, skimmed two sides to total gage of from 0.050 in. to 0.055 in., containing at least 400 ends, rolled in such manner as to keep all cords parallel. The length of the fabric core shall exceed the length of the rubber roll by at least 2 ft. on each end, to facilitate the attachment of cables for pulling the sealing device into place.

Breaker Strip. The breaker strip shall be made of two plies of 10½-oz. breaker fabric, frictioned two sides; skimmed two sides to a total gage of 0.120 in. Skim one side with 0.015-in. graduate stock containing 80 to 85 per cent by volume of new plantation rubber. Skim the other side to complete the 0.120-in. gage with cushion stock having at least 95 per cent by volume of new plantation rubber. The breaker must be slit to avoid all laps except final longitudinal lap which shall be approximately ½ in.

Tread Stock. The tread stock shall consist of high-grade material containing 65 to 68 per cent by volume of new plantation rubber free from reclaim, whiting, silica and other coarse material, balanced in compound to permit

thorough cure of all elements without surface over cure. The tensile strength of the tread stock shall be not less than 3,200 lb. per square inch.

General Notes. The different elements shall be well cured and well bonded together so as to withstand the separation tests generally specified for high quality pneumatic cord tires. The surface finish shall be equivalent to that obtained from curing in a jacket of fiber containing 75 threads per inch in both warp and fill. The surface shall be free from spiral corrugations or longitudinal ridges.

Operation of Gates—The drum gates were put in service at the beginning of the 1924 irrigation season. Certain factors in connection with unfinished portions of the work made it desirable to confine the spillway discharge to the middle gate. Unfortunately the balanced valve for this gate was too tight and would not open under the pressure available. Rather than interrupt service to adjust the valve, it was decided to operate the gate by hand until the end of the season. The 16-in. auxiliary valve was used for this purpose. The gate proved to be much more stable under hand control than was expected. The two end gates were held in reserve, ready to be put into service if required.

At the end of the irrigation season the middle gate was lowered and its control valve adjusted. All of the gates were then put under automatic control, and appeared to operate satisfactorily in every respect. However, the flow available was small, and it was not possible to test the automatic operation throughout the full travel of the gates. After a few days' trial, it was necessary to draw down the water behind the dam to permit the installation of gates and penstock connections for the hydro-electric units of the power plant, which work was started in the fall of 1924. Plans are being made to run a full set of tests this summer, should a high-water period occur. The automatic operation has been entirely satisfactory as far as tested.

Designs for the dam and the spillway were prepared under the direction of J. L. Savage, designing engineer, Bureau of Reclamation. The drum gates were fabricated by the Omaha Steel Works of Omaha, Neb., and were erected by government forces under the supervision of Walter Ward, construction engineer, Bureau of Reclamation.

Tests of Bond Resistance in Reinforced-Concrete Beams

Results of Experiments by Bach and Graf Some Years Ago in Germany Give Valuable Information for Design of Reinforcing Bars—Four American Deformed Bars Among Types Tested

By W. A. Slater
Engineer-Physicist, Bureau of Standards, Washington, D. C.

An extensive series of bond tests with concrete beams was reported in Nos. 72-74 (1909) of "Forschungsarbeiten auf dem Gebiete des Ingenieurwesens" by C. Bach and O. Graf. The tests were made to test the effect on the bond resistance of certain variables existing in the concrete and of other variables in the beams. Among the former were variations in water content, character of aggregate, proportions of materials, cements, age and storage. Among the latter were variations in character of the surface of plain bars, form of section of plain bars (rounds, flats, angles, T's and I's), types of deformed bars, and position of load points. In all, 194 beams were tested and important results were obtained. Many of the results are valuable for establishing standards for design and as they have not found their way generally into the textbooks in this country, they are recorded here although they are of long standing.

The latest report of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete specifies that "An approved deformed bar shall be one that will develop a bond strength at least 25 per cent greater than a plain round bar of equivalent cross-sectional area," but specifies no standard method of making tests to determine bond resistance. The specified working bond stress for plain bars is 4 per cent of the compressive strength of 6x12-in. concrete cylinders. For deformed bars it is 5 per cent of the compressive strength.

Usual Form of Tests—Most of the bond tests in this country have employed pull-out specimens in which a direct pull has been applied to a bar embedded in a concrete cylinder or prism, though it is almost always in flexural members that bond stresses are critical. In applying the results of pull-out tests to the determination of permissible bond stresses for the design of beams it is necessary to make a comparison of the bond resistance developed by bars of different types at certain arbitrarily selected stages of the test. If the bond resistance at first slip were used for the comparison, the advantage of even the best deformed bar would be questionable. On the other hand, if the resistance at maximum load were used almost any deformed bar would show a great advantage over a plain bar.

If a beam, so designed as to fail by slipping of the bars, is used as the test specimen, service conditions are approximated and the computed bond resistance at maximum load seems to offer a better criterion for judging the value of a deformed bar than the bond resistance at an arbitrarily selected amount of slip in a pull-out test. Of course, even with a beam as a test specimen, certain elements are neglected such as the tendency of a reinforcing bar to slip under long continued or repeated load. It seems reasonable, however, to believe that a long continued load would be more likely to overcome the slip resistance of a plain than that of a deformed bar. If this is so the advantage of a deformed bar over a plain bar would be at least as great for use with a long continued load as is found for a load of short duration and probably it would be greater. It was found by Abrams (Bulletin 71, University of Illinois, pp. 168 and 198) that under repeated loads, corrugated bars resisted slip more effectively than did plain bars and this fact seems to support the conclusion that deformed bars would show advantages with long continued loads.

It is worth while to summarize some of the results obtained by Bach and Graf, especially the values of these results for the bond resistance of plain round and deformed bars, and those showing the relation between

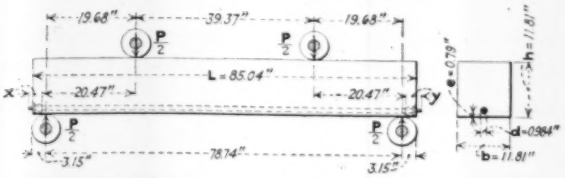


FIG. 1—DESIGN OF BEAMS TESTED IN BOND STRESS

bond resistance of plain round bars and compressive strength of the concrete. These form a valuable addition to the available data on bond resistance.

All values quoted have been converted from the metric to English units. No other computations were necessary since all the computed unit stresses were furnished in the original report. The stresses check very closely with those computed by the methods which have become standard in the United States. In the computations, the ratio, n, of the modulus of elasticity of the steel to that of the concrete seems to have been about 7.5. Figs. 3 and 9 have been prepared from the data reported in the tables, and the loads at first slip have been added to Fig. 4. Otherwise the figures presented here have been reproduced directly from the original paper.

Type of Beams—The beams were 11.8 in. square in cross-section and 7 ft. 1.04 in. long overall. They had a span of 6 ft. 7.8 in. The load was applied at the one-fourth points of the span as shown in Fig. 1.

The concrete used was made from 1 part by volume of Heidelberg portland cement, 2 parts of Rhine sand and 4 parts of Rhine gravel. Control specimens, cubes 11.8 in. (30 cm.) on an edge, were made only with the beams having plain bars. The average compressive strength of the concrete was 3,500 lb. per sq.in.

Of the bars used in the beams four were of American manufacture. These were the Johnson (the old type of corrugated bar), Diamond, Lug and Cup bars. In addition plain round bars and "wave" bars ("Welleneisen") were used. The bars are shown in Fig. 2. The plain round bars were approximately 1 in. in diameter (25 mm.) and had an average sectional area of 0.768 sq.in. The deformed bars generally had a slightly smaller sectional area. The yield-points of the reinforcement and the computed tensile stresses for the maximum loads on the beams are plotted in Fig. 3. It will be seen from this diagram that in several of the beams the yield-point and the tensile stress were so nearly the same that the beam must have been close to failure by tension in the reinforcement. However, the photographs showing the cracks in the tested beams strongly indicate that failure was not due to the high tensile stress in the reinforcement. Fig. 5 shows the cracks in the beams having plain bars. As typical of the beams having deformed bars, the photographs of the beams reinforced with Diamond bars are shown in Figs. 6 and 7. The presence of the diagonal tension cracks indicates that the beam may have been near failure by diagonal tension under the maximum load. Some diagonal cracks were present in most of the beams having deformed bars. However the shearing stresses plotted in Fig. 3 for the maximum load show that the highest shearing stress was about 145 lb. per sq.in. or about 4 per cent of the compressive strength of the cubes. With bars thoroughly anchored against bond failure, diagonal tension failure is not likely to occur at a shearing stress less than 8 per cent of the compressive strength of the concrete when tested as a cylinder whose height is twice its diameter (say about 6 per cent of the strength from cubes), and it seems safe to conclude that none of the failures were primarily due to diagonal tension.

Having eliminated (at least for the greater part) the tensile stresses and the shearing stresses as causes of failure, it appears reasonable to use these results for a comparison of the bond resistance of different types of bars.

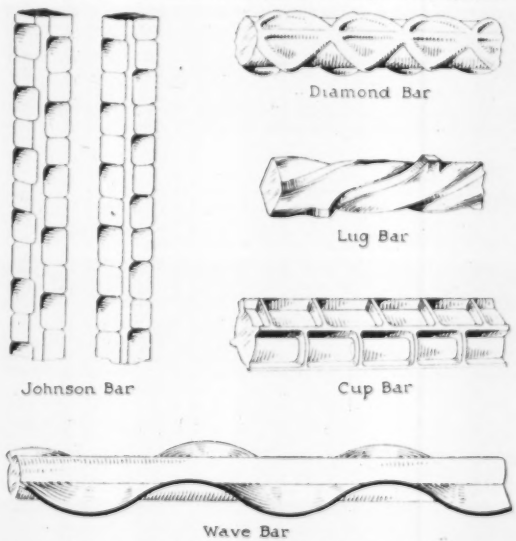


FIG. 2—TYPES OF DEFORMED BARS USED IN THE TESTS

The report gives for each group of three beams the maximum plus and minus variations of the computed bond stress (for maximum loads) from the mean value for that group. A summary of these variations follows:

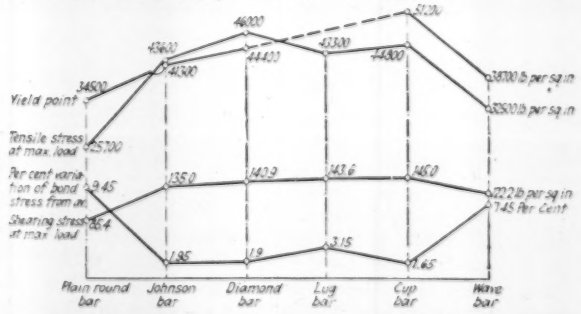


FIG. 3—RESULTS OF TESTS WITH DEFORMED BARS

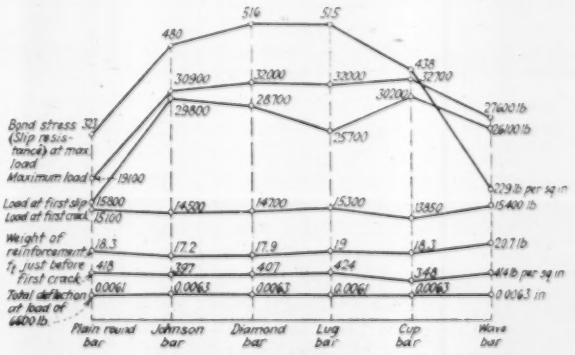


FIG. 4—FURTHER RESULTS OF TESTS WITH DEFORMED BARS

Type of Bar	No. of Groups	Maximum Variations from Mean Bond Stress at Maximum Load (Per Cent) Plus	Minus
Round bars	28	9 6	8 1
Deformed bars	5	3 6	2 8
Flat bars and structural shapes	6	7 1	9 7
Average for all tests	39	8 5	7 7

In Fig. 3 the average of the maximum positive and negative (signs disregarded) variations are plotted for the six groups included in that figure.

Although the slip of the end of the bar was tabulated in the report, the authors seem to have based their conclusions mainly on the maximum loads, giving little or no discussion of bond stresses at loads causing the first end slip. However the tables seem to justify the conclusion that although the load causing the first slip of the reinforcement was little greater than the load causing the first crack for the beams having plain bars, where deformed bars were used the load causing first slip was much greater than that causing the first crack.

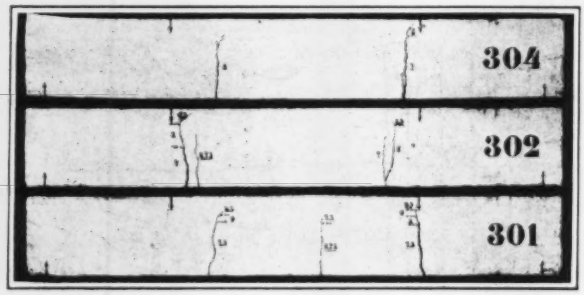


FIG. 5—BEAMS WITH PLAIN BARS; SIDE VIEW AFTER TEST

The average loads causing the first crack and those causing the first slip have been plotted in Fig. 4.

Fig. 9 shows the relation between the compressive strength of the concrete from the cube tests and the bond resistance at maximum load for beams reinforced with plain round bars. The mean line shown corresponds to a bond stress of 0.107 times the compressive strength. The other lines are 12 per cent higher and 12 per cent lower, respectively, than the mean line and include between them all but five of the points. A similar relation between bond resistance for pull-out specimens and compressive strength is shown in "Tests of Bond Between Concrete and Steel," p. 95, by D. A. Abrams, Bulletin 71, University of Illinois Engineering Experiment Station. He found the average ratio of bond resistance from pull-out tests to the compressive strength of cubes to be 0.166 for a slip of 0.0005 in. and 0.24 for the maximum load. Since Abrams found lower bond resistance for beams than for pull-out specimens, the fact that the slopes of the lines in Fig. 9 are less than the corresponding slopes found by Abrams for pull-out tests does not indicate an inconsistency between the results of the two investigations. The following is a free translation of the comments of the authors of the report, on the significance of the tests with deformed bars:

"For the slip (bond) resistance computed according to the official methods (using the average circumferences of the bars) the values given in Fig. 4 were obtained. The American bars show therein a considerably higher slip resistance than straight round bars. The greatest increase over the plain bars was 60 per cent (for Diamond bars) and the least was 36 per cent (for Cup bars). The difference would have been still greater if a splitting off of the encasing concrete had not taken place. (The splitting referred to by the authors is shown by the longitudinal cracks apparent on the bottom of the beams in Fig. 7.)

"On the basis of the slip resistance per unit of total surface area the "wave" bar ("Welleneisen") is inferior to the plain round bar. If the comparison is made on the basis of the maximum load per pound of

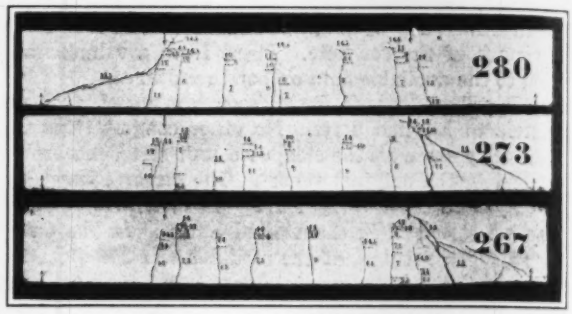


FIG. 6—BEAMS WITH DIAMOND BARS; SIDE VIEW AFTER TEST

reinforcement the relative positions are indicated by the following table:

Bar	Maximum Load per Pound of Steel, Lb.
Johnson	3,960
Diamond	3,950
Lug	3,720
Cup	3,930
Wave	2,935
Plain round	2,305

With this comparison the Johnson, Diamond, Lug and Cup bars appear to have about equal values. A considerably lower value was found for the wave bar and a still lower value for the plain round.

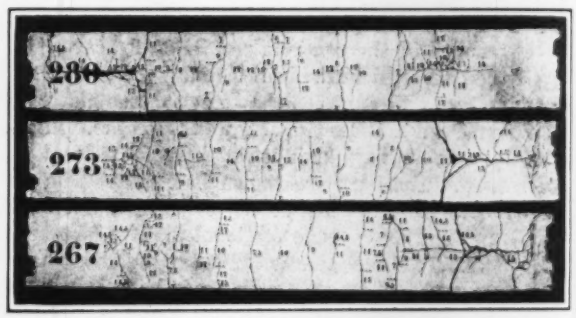


FIG. 7—BEAMS WITH DIAMOND BARS; BOTTOM VIEW AFTER TEST

"With all the beams longitudinal cracks were observed in the concrete covering before the beginning of slip. With progress of the slipping of the deformed bars the adjacent concrete burst off at the maximum load. Figs. 7 and 8 show the bursting effect of the bars on the beam. Fig. 8 is especially instructive. Here the reinforcement (a Lug bar) has split the end of the beam entirely apart.

"After the test, pieces of concrete remained in the recesses of the Johnson, Diamond and Cup bars and on the lugs of the Lug bars. As the slip resistance was overcome the bars had sheared off portions of the concrete which resisted their movement."

Comparison of Values—It is interesting to compare the high value of the slip resistance found for the American deformed bars with the values for plain round bars which had been heavily rusted. The American bars showed 427 to 516 lb. per sq.in., a little greater

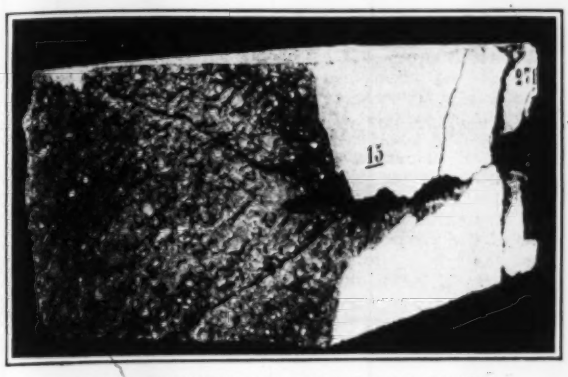


FIG. 8—MANNER OF FAILURE OF BEAMS REINFORCED WITH LUG BARS

on the average, than the 416 lb. per sq.in. found for the rusted bars. The considerable damage to the beams which had taken place with the American bars did not occur with the rusted plain bars.

In comparison with the beams which employed plain round bars the beams with Johnson, Diamond and Cup bars had a large number of cracks. The beams with Lug bars and those with wave bars had a larger number of cracks than did those with plain round bars but not so many as those with Johnson, Diamond and Cup bars. Where the cracks were greater in number they were smaller than those in the beams with plain round bars.

Of special interest is the curve in Fig. 4 showing the load under which the first crack appeared. It is very nearly a horizontal straight line. So also is the curve for the tensile stress, f_t, computed according to the official regulations for a load just before the occurrence of the first crack. A similar curve shows the total deflection under a load of 6,600 lb.

This abstract includes only a small part of the report which gives data on the effect of many other variables on the bond resistance. The data given here bear especially on the design of a standard test specimen for comparing the bond resistance of different types of reinforcing bars.

In a beam to be used as a test specimen for bond it is essential that before the tensile stress in the steel

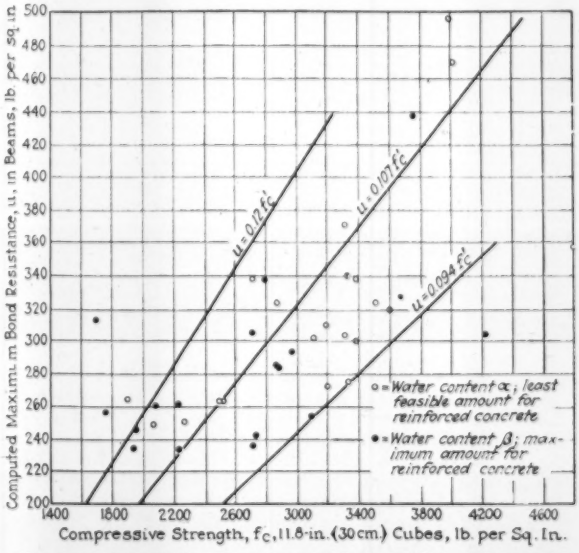


FIG. 9—RELATION BETWEEN COMPRESSIVE STRENGTH OF CONCRETE AND MAXIMUM BOND RESISTANCE

reach the yield-point or the shear in the beams exceed about 10 per cent of the compressive strength of the concrete, a very high bond stress shall have been developed. Otherwise failure is likely to occur by tension in the steel or by diagonal tension in the beam and the test will yield little information on bond resistance.

Assuming that structural grade steel may be used with concrete having a compressive strength, in 6x12-in. cylinders, of 2,000 lb. per sq.in., stresses of 40,000, 200 and 500 lb. per sq.in. in tension, shear and bond respectively, may be taken as about the proper relation between stresses to insure bond failure with either plain or deformed bars. This will require a beam 7.85 in. wide and with load points 20 in. from the support. Whatever depth is chosen, the above relations between computed stresses will remain the same. Therefore a beam 8 in. wide, 12 in. deep, reinforced with a 1-in. bar and having a span of 60 in., with loads at the one-third points of the span, seems to meet the requirements. Such a specimen should be provided with stirrups. For this purpose vertical U-stirrups of ½-in. round, spaced 3 in. c. to c., are suggested. The most potent argument against the use of stirrups in a beam designed as a bond specimen will be probably that in practice not all beams have stirrups, that the stirrups in the test specimen will add to the bond resistance and that therefore a value which is too great for design purposes will be obtained from the tests. To the writer, these objections to the use of stirrups do not seem valid. In a beam reinforced with a good deformed bar it is difficult to develop a load high enough to determine the maximum bond resistance if the beam does not have stirrups because the failure is likely to be by diagonal tension. In practice, it is not permissible generally to use a shearing stress greater than 40 lb. per sq.in. without providing stirrups and at this shearing stress the bond stress will usually be quite low. Since practically all reinforced-concrete beams in which the bond stress is critical have stirrups there should be no objection to the use of stirrups in the standard test specimen.

This statement does not fully take into consideration the conditions frequently existing in footings where, on account of the use of reinforcing bars at right angles to each other, cracks may open along a bar and permit slipping at comparatively low bond stresses. Such cases require special and careful consideration.

It is true that the same object could be attained (in part at least and possibly better) by increasing the width of the beam as by using stirrups. It is believed, however, that the narrower beam with stirrups will keep the test conditions more strictly within the field in which the results are to be applied in design than will a wider beam without stirrups. Unwieldiness of test specimen also will be guarded against by the use of the narrower beam. Some investigation aimed at determining the proper form of test specimen is much needed. Such an investigation should also obtain data bearing on the desirability of using a long continued load in the standard tests.

Completion of the Welland Canal

Completion of the Welland ship canal connecting Lake Erie and Ontario is expected during the year 1929, according to estimates of the Ontario government. Up to the end of March, 1925, the sum of $51,200,000 had been spent upon the project. Approximately $100,000,000 is the estimated total cost.

Refuse Collection and Disposal in Pittsburgh

Engineers Find Record Per Capita Collection Under Contract and Advise Continuation of Plan With Minor Changes

Abstract of a Report made to the City of Pittsburgh, Pa., by Morris Knowles, Incorporated, Engineers, Pittsburgh, Pa.

THE MAIN conclusions of this report are: (1) The quantities of garbage and rubbish collected in Pittsburgh, Pa., are higher per capita than in any other American city (see table). (2) Pittsburgh is probably the only large city in the United States in which a complete collection of garbage and household trash or rubbish is carried out entirely by contractors. (3) The contract system has proven cheaper than the amount estimated for municipal ownership and operation. (4) Unique features of the contracts now in force as well as suggested improvements in these contracts warrant the continuance of the contract system, with some recommended changes.

While the amount of garbage per capita in Pittsburgh is only slightly greater than that for Washington, D. C., it is considerably greater than in any of the other cities listed in the accompanying table. None of these cities, however, compares in any way with Pittsburgh in the quantity of rubbish collected per capita. This can be accounted for primarily by the complete and thorough system of collection now in use, and particularly by the fact that the contractors are paid on a tonnage basis and are careful therefore to get all the material available and to keep very accurate records. The fact that Pittsburgh is a gas burning city also tends to increase the quantity of household rubbish and the amount of soiled and unsalvageable material.

Contractors—Contracting companies now perform the entire service for the city of Pittsburgh, one confining its operations to the "North Side" and the other to "Peninsular Pittsburgh" and the "South Side." Both collect garbage and rubbish, separately. The garbage is reduced with reclamation of grease and tankage. Rubbish is incinerated after salvaging to some extent. No public collection of ashes is made.

In one respect the system in Pittsburgh is somewhat different from that of other cities of its size.

Where the service is not carried out entirely under municipal ownership and operation, other municipalities generally contract for the disposal of material after it is delivered to the contractor either on scows, at a loading station, or at the disposal plant. Cincinnati has complete collection and disposal of garbage by contract but Pittsburgh is the only large city having complete collection and disposal of both garbage and rubbish by contracting corporations. In fact, Pittsburgh is one of the few gas burning cities which has a complete and thorough rubbish collection system. The continuance of the contract system is the special recommendation of this report, and is brought about primarily because of cost, and secondly because of certain provisions which can be incorporated in the contracts.

Cost—In view of the large quantities per capita, it was deemed advisable to make all studies on a tonnage basis. The present weighted average cost of collecting garbage in Pittsburgh is $3.80 per ton, while the average in seven of the cities in the United States, where records were available, is $4.47 per ton, excluding in both cases any allowance for interest, depreciation, federal taxes and profit. The total present cost of collection and disposal, including an allowance of $1.50 per ton to the contractors for interest, depreciation, profit and federal taxes, is $6.30 per ton for garbage and $7.67 per ton for rubbish. (Price bid less a profit-sharing rebate of $1.50 a ton.) Studies of the cost of owning and operating the system municipally showed that the combined collection of garbage and rubbish would be cheaper than the separate system now used. The estimated cost for 1925 on the basis of combined collection and incineration is $6.50 per ton, which cost, it is estimated, will gradually reduce to about $6.30 per ton by 1935. The estimated cost is but slightly less than the average actually being paid the contractors. Assuming the same efficiency by the municipal organization as now practiced by the contractors, and including a return on an investment in plants and equipment of $3,500,000, little or nothing could be saved by changing over from the contract system to municipal ownership at this time.

Special Features of Contract—After a very complete study of the advantages and disadvantages of the contract system, it is recommended that (1) the contract provide primarily for the continuance of the system of paying a definite rate per ton for collection and disposal; (2) for the imposition of penalties as liquidated damages for failure of the contractors to collect in any specific case; (3) that there be a sliding scale for rebating to the city profits in excess of given amounts per ton.

The price per ton basis furnishes an incentive to the contractor to collect all material. Since his profit is increased with the additional tonnage disposed of, this will result in uniformity and completeness of collection. Fines are now imposed upon the contractors upon failure to collect within 24 hours after the filing of a complaint. The changes recommended in the contract would call for the fining of the contractors upon the filing of all bona fide complaints. This would tend further to reduce the total number of complaints.

GARBAGE AND REFUSE COLLECTIONS IN NINE CITIES

	Pounds per Capita per Year	
	Garbage	Rubbish
Pittsburgh	328	375
Washington, D. C.	315	79
Detroit	257	...
Cleveland	247	...
Philadelphia	246	...
Boston	208	85
Milwaukee	195	...
Rochester	148	66
Buffalo	...	116

Under the present contract there is rebated to the city any amount by which the earnings of the company exceed $1.50 per ton; this amount being fixed as a fair allowance for interest, depreciation, profit and federal taxes. The report recommends that a sliding scale be substituted. This sliding scale should provide a means by which the city and the contractor may both share in the difference between the cost and the bid price. A rebate of this nature would consist of an increasing proportion of the difference accruing to the contractor, so that the greater the economy achieved, the greater the profit to the contractor. It may be that this modification could be varied as experience indicated, and therefore but a slight change is recommended immediately. The results of experience with such a change will indicate whether additional steps might be taken another year. The wording of the suggested contract pertaining to this provision is as follows:

"Provided it is the intent and meaning of this contract that the above-mentioned rates shall be the maximum to be received by the contractor for said work and that the contractor agrees that said rate shall be reduced to a rate equal to the cost of doing the work according to the specifications, which cost shall not include any allowance for depreciation of plant and equipment, plus $1.50 per ton net profit, out of which profit are paid any taxes due the United States Government from the contractor; provided, however, that should the reduction below the above-mentioned rates exceed 75c. per ton, then the contractor shall be entitled to participate equally with the city of Pittsburgh in all savings above 75c. and not exceeding $1.25, and provided further that should such saving exceed $1.25, any amounts in excess of $1.25 shall accrue 60 per cent to the contractor and 40 per cent to the city of Pittsburgh."

Thus the city can obtain all the advantages of cost-plus-variable-fee contract, without the attendant disadvantage of taking away from the contractor the incentive for greater profit due to efficient performance. Such a contract would have the additional advantage of fixing a maximum price which may not be exceeded and therefore would limit the liability of the city under the contract.

(Subsequent to submission of this report, the city council, over the veto of the mayor, has approved contracts with the old contractors upon the same basis as that of last year—$7.03 per ton for garbage and $8.27 for refuse, with a rebate to the city of earnings in excess of $1.50 per ton. There was no competition.)

Dirt Roads Improved by Lime Mixed with Surface Soil

Test Roads in Missouri Show Less Mud and Fewer Ruts—Maintenance Made Easier—Theory of Action Unexplained

BY E. J. MCCAUSTLAND
Dean, School of Engineering, University of Missouri, Columbia, Mo.

Extract from a paper read before the National Lime Association at its convention at Briarcliff Manor, New York, May 26-29, 1925.

THE common agricultural soils containing silts, loams or clays are never entirely suitable for all-weather roads; and yet it is likely that more than 80 per cent of all country and by-roads for generations to come will of necessity be constructed upon and of such soils. It is a pressing problem to know what can be done to improve this situation.

In the fall of 1923 the Engineering Experiment Station of the University of Missouri entered into a co-operative agreement with the National Lime Association to conduct field and laboratory investigations in an attempt to determine the effect of the use of commercial lime on earth roads, with the hope of reducing both the inconveniences and the expenditures caused by the formation of mud. The work was placed directly in charge of Horace W. Wood, Jr., as research fellow in the experiment station and the material used in the investigations was donated by some of the constituent companies of the National Lime Association.

Laboratory tests were begun in December, 1923, to determine the more obvious physical characteristics of the soils under investigation and to become acquainted with the changes wrought in those characteristics by the addition of predetermined percentages by weight of lime. At a somewhat later time selected stretches of clay roads, subject to heavy traffic, were treated with varying percentages of hydrated lime and these stretches have been kept under observation for a number of months. The winter season of 1924-25 was an extremely trying one on these test roads because of a heavy fall of sleet and ice early in December and a continuation through the winter of alternating periods of thawing and freezing. In every case, however, these tests sections, all of which have been carrying traffic during the past seven to eleven months, show to the most casual observer the distinct advantage of lime admixtures in preventing surface stickiness and the formation of deep ruts under traffic. In brief, it seems to have been established beyond question that the addition of hydrated lime in the proportion of from 2 to 5 per cent dry weight to clay soils will materially reduce the tendency to form mud and prevent to a great degree the formation of ruts; there is reason to believe, however, that such treatment will not in any degree lessen the production of dust and in some cases the dust may be increased.

Test Sections—The following facts are abstracted from Mr. Wood's monthly reports: Early in July, 1924, a stretch of 500 ft. of road near Hallsville, Mo., was treated with hydrated lime to a depth of 5 in. On 250 ft. the proportion used was 2 per cent by dry weight and on the remaining 250 ft. 5 per cent by weight was incorporated in the soil. Later a section of road 250 ft. long was treated with 5 per cent of hydrated lime incorporated to a depth of only 2 in. for purposes of comparison. These road sections have been under careful observation since the original treatment and especially after rains; the clay and lime mixture does not stick on the wheels of passing vehicles but smooths out and packs much more quickly than does the untreated clay; there appears to be a more uniform vertical distribution of moisture in the treated soil, and a reduced moisture content at the bottom of the treated section. Maintenance is therefore more easily accomplished on the treated portion because there is no formation of the hard crust on the top before the road is sufficiently dry to drag, such as is characteristic of the untreated clays. No marked difference appears in the results brought about by the different depths of incorporation and this is of some importance since it so directly affects cost of treatment. The laboratory tests of the heavy clays indicated a slight retardation of surface evaporation on the treated samples but this fact seems to have no practical significance. Some two months after the Hallsville experiment was begun it was observed that there was no development of ruts in the treated portion of the road following heavy rains while the untreated portion showed ruts from 2 to 4 in. in depth. Furthermore, the maintenance of the treated stretch of road seemed to be much more easily accomplished than that of the untreated part, mostly due to the fact that it could be begun much more promptly after the rains ceased.

Two other important test roads were established; one during September, 1924, in the Missouri River bottom lands near Jefferson City where the native soil is known as a Wabash clay. This was divided into two sections of 500 ft. each, treated with 5 per cent hydrated lime, one section to a depth of 2 in. and the other a depth of 6 in. A second stretch of 400 ft. was established about Nov. 1 at Matney near St. Joseph, Mo., on a heavy blue clay with 5 per cent of lime to a depth of 6 in. On March 1 after the winter season the Jefferson City test road was found to be in excellent condition as compared with the untreated portions particularly in the matter of freedom from ruts. This was especially satisfactory considering the trying weather of the winter season. The advantageous results of lime treatment, however, were not so apparent on the St. Joseph road so early in the season. This was in some degree due to the fact that treatment took place late in the autumn and the road was not thoroughly consolidated when freezing occurred. The ice cap which formed in December persisted for some weeks and when the breakup came there was a considerable development of mud for a short time. However, the traffic soon compacted the roadway and since that time the treated section has shown a marked advantage in comparison with the adjacent portion of the normal clay. An inspection on April 11 showed it to be in good condition. The following tabulation offers in condensed form information relating to the various field test sections:

Date of Treatment	Location	Kind of Material	Length of Section Ft.	Depth of Treatment, In.	Per Cent wt. hyd. Lime	Cost per 100 Ft.
1924	Hallsville Road:					
7-10	Section 1	Clay	250	5	2	$19 15
7-10	Section 2	Clay	250	5	5	36 75
9-1	Section 3	Clay	250	2	5	15 13
	Jefferson City Road:					
9-15	Section 1	Wabash	500	2	5	16 05
	Section 2	Clay	500	6	5	38 26
11-1	St. Joseph Road	Clay	400	6	5	48 86

In all cases, except the last, the width of the roadway treated was 14 ft. The St. Joseph stretch was 20 ft. wide, but the cost indicated above is, for purposes of comparison, computed on the basis of 14-ft. width. The results of the investigation to date from the practical viewpoint seem to be encouraging, although the effect of a long period of time on the stability of the mixtures is yet to be determined. So far, the changing moisture content, due to alternate wetting and drying, the wide ranges in temperature and the action of traffic have not destroyed the favorable effects of the lime, but it is deemed wise to extend the observations over a longer period of time.

Only negative results may be reported, however, in relation to the fundamental physical phenomena investigated; in the words of Mr. Wood, "the tests . . . do not explain the basic action which results from the lime admixture." These facts are apparently established, however. The specific gravity of the soil is only slightly reduced by adding hydrated lime; the moisture holding capacity and moisture equivalent are reduced in heavy clays; the rate of evaporation is slightly retarded; but there is a more rapid capillary movement of the moisture after treatment; the voids in the soil become enlarged allowing an increased rate of percolation; and the bearing power at the higher moisture content is increased. We cannot, however, at this time offer a scientific explanation of these phenomena. It will no doubt need the co-operative efforts of the engineer, the physicist, the geologist and the colloidal chemist to lay bare the whole story of cause and effect.

Correcting the Name of V. P. Maun

The author of the article on Abrams' Water Cement Ratio that appeared in *Engineering News-Record* May 28, p. 885, was V. P. Maun, and not V. P. Mann as given there.

One of a Series of Articles on the Details of Design and Layout of Different Types of Industrial Buildings

Building for Industrial Research and Testing Work

Housing Experimental Engineering Activities of Motor-Truck Factory—Laboratories and Machine Testing Rooms

INDUSTRIAL research and experimental testing work on materials and mechanism used in motor-truck construction are the purposes for which an engineering and laboratory building has been established as a part of the motor-truck manufacturing plant of the White Motor Co., Cleveland, Ohio. This building not only provides improved facilities for all the experimental work of the company, but also releases for physical and chemical testing certain portions of the plant buildings which have been occupied as laboratories.

FIG. 1—ENGINEERING BUILDING FOR THE WHITE MOTOR CO.

In view of the hard service and rough usage to which motor trucks are subjected, it is important that their engines and other mechanism should be able to withstand such severe service; this requirement is the basis of much experimental work on special grades of material and special types of construction. The company's combined design and research department establishes standard practice in motor work, develops new designs and perfects them by experiments and tests, so that they will be in condition for handling by the production department without further experiment. The engineering department controls all changes and refinements in designs, and conducts research into new devices and methods which may be applicable to motor transportation.

This engineering building, Fig. 1, is 160x150 ft., with a one-story portion 110 ft. wide which is divided into two equal parts by a tile fire wall and is covered by a steel-frame sawtooth roof with trusses of 40-ft. span in rows 10 ft. apart. At one side of this portion of the structure is a two-story building 160x40 ft. containing offices, laboratories and the designing department. This latter portion of the structure is designed for two additional stories when required, and the entire building can be extended at the rear and on one side. A basement extends under the entire area. Fig. 2 is a typical section of the one-story shop and Fig. 3 is a plan of the first floor.

Reinforced-concrete construction is used for the basement, with columns spaced 20x20 ft. c. to c. and carrying the first floor which is designed for 350-lb. load. The greater part of this floor is a 9-in. flat slab with four-way reinforcement, but in the experimental shop it is a paneled slab with central 8-in. panels 12x12 ft., while over the columns are belts 8 ft. wide and 12 to 16 in. thick. This floor slab is made exceptionally heavy in order to absorb the vibration that might result from a number of dynamometers running simultaneously. Built into this slab, in the testing or dynamometer room, there is a system of channel inserts and covered drains that together give great flexibility for setting up testing equipment.

Above the first floor the structure is of steel framing, of somewhat heavier design than is usual for such buildings. The upper floor, designed for a 150-lb. load, is of tile-joist construction, with 24- or 26-in. girders forming panels 16 ft. wide, with transverse joists, as shown in part by Fig. 3 and in detail by Fig. 4. With 24-in. beams, the joists are 4x8 in., spaced 16 in. c. to c.,

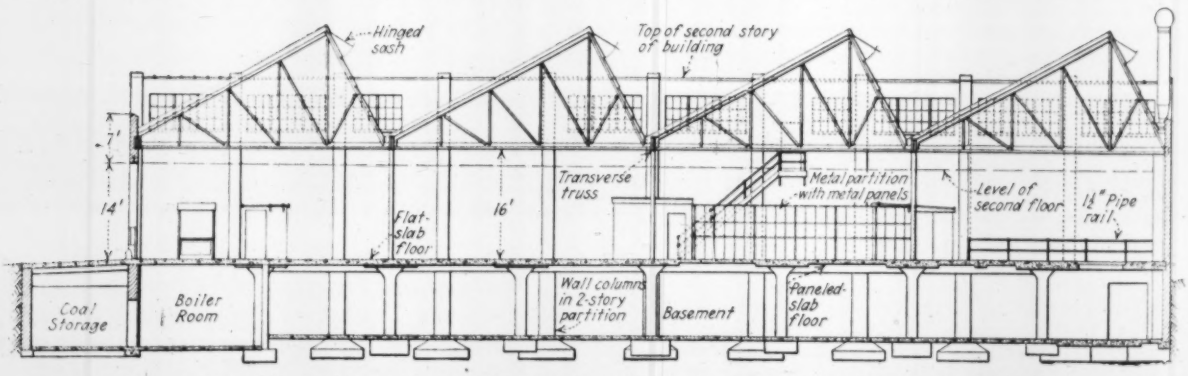


FIG. 2—TYPICAL SECTION OF ONE-STORY SHOP OF WHITE MOTOR CO. RESEARCH BUILDING

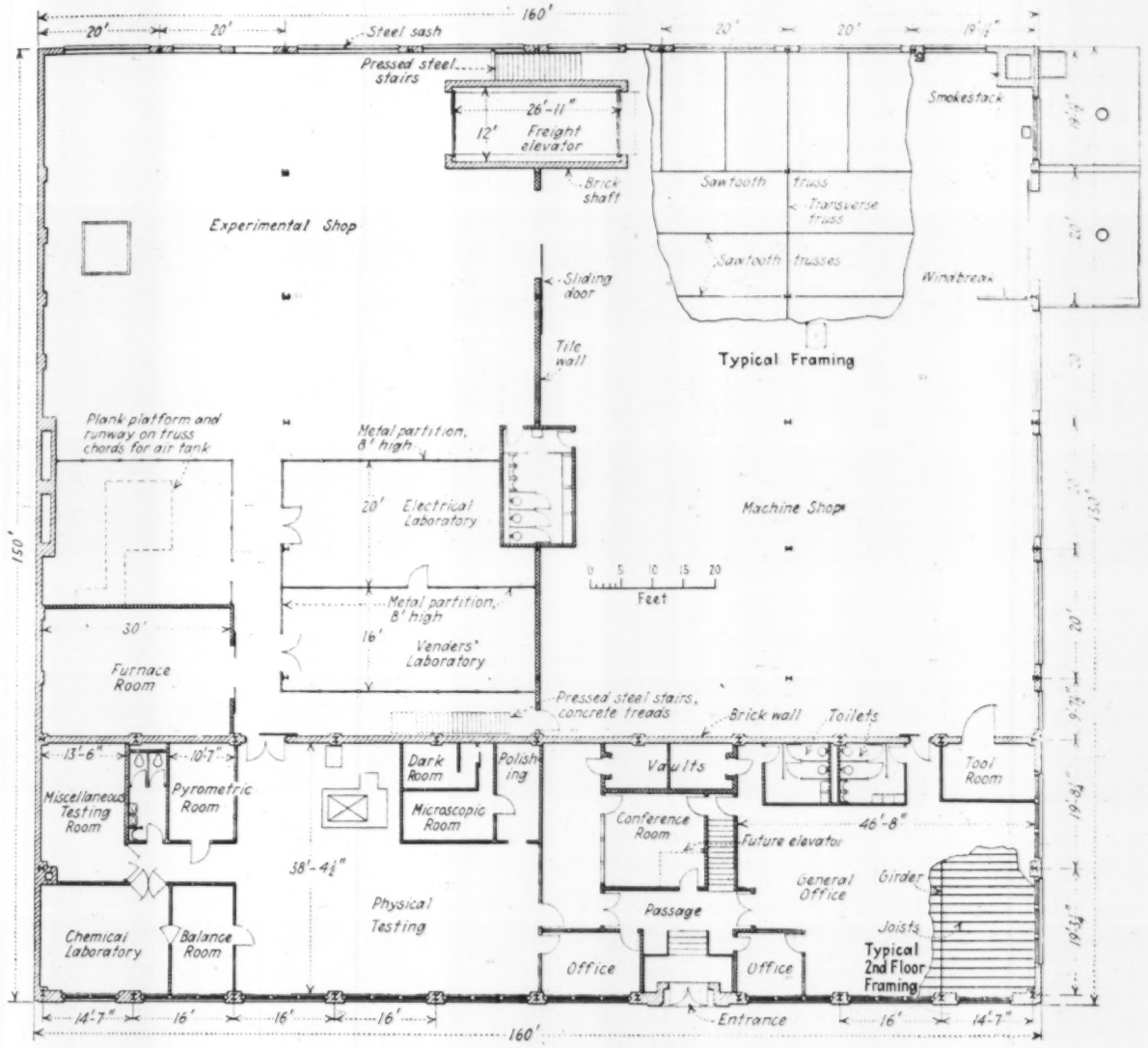


FIG. 3—PLAN OF ENGINEERING AND TESTING BUILDING

and having a 2-in. top slab; the tile fillers are 6x12 in. In the heavier panels with 26-in. beams, the 2-in. top slab has joists 6x10 in. spaced 18 in. c. to c., with tile fillers 8x12 in. In view of the future additional stories, provision is made for an elevator shaft, by building a suitable frame in the floor system and filling this with a removable slab (see Fig. 4). In the one-story portion of the building, the sawtooth roof framing is designed to carry 5-ton suspended loads on overhead traveling trolley hoists or transfer cranes.

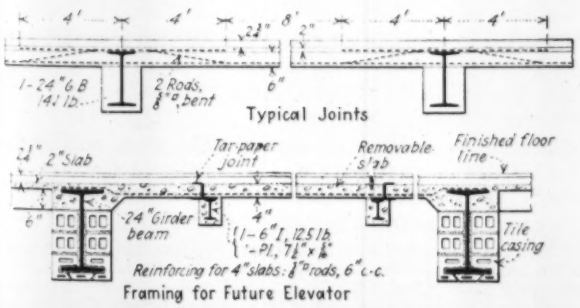


FIG. 4—STRUCTURAL DETAILS

Red pressed brick is used for the outer walls, with steel sash and factory ribbed glass for the windows in the shop portion and in the rear of the two-story portion, but with wood sash in the remainder of the two-story building. Interior partitions are of brick and tile. Over the 9-in. slab of the first floor the floor construction consists of 1 in. of tar-rock, 2-in. plank and a wearing surface of 1¼-in. square-edged maple. An exception to this is in the portion for offices, where ⅞-in. maple flooring is nailed to sleepers embedded in the fill; the latter construction is used also for the entire upper floor. The future third floor forms the roof of the second story. In the sawtooth roof, the flat slopes are covered with plank and ceiled on the under side with metal lath and plaster. The basement is utilized for storage and also contains the heating boiler and coal storage room.

On the first floor of the two-story front portion of the building are the engineering and metallurgical offices, physical testing room, chemical laboratory and microscope rooms. A design department occupies the entire second floor. The one-story portion at the rear, divided into equal parts by a tile wall, houses the engi-

neering research laboratories and a machine shop for use in connection with the experimental and research work.

About six dynamometers can be installed on the testing floor for testing engines, axles, transmissions and other parts or mechanisms. At each dynamometer station there are provided hot and cold water, compressed air at high and low pressure, gas and vacuum pipe connections, there are also electric connections for 110,- 220- and 440-volt alternating and direct current, so arranged as to make it impossible to connect from one potential to the other. The exhaust ventilating system leads through a separator into a blower of such capacity and so arranged that the back pressure on each engine can be controlled even when all dynamometers are running at full load. There is also a complete equipment of chemical and physical testing apparatus.

This engineering building was designed by the Watson Co., architects and engineers, Cleveland, in co-operation with Frank Brown, chief engineer, and H. Hylkema, plant engineer of the White company. It was built under their supervision by the George A. Rutherford Co., Cleveland. Its total cost was nearly $300,000, including equipment, and it houses about 100 men employed on the research work, including technical men and workmen.

Design Considerations in Dix River Rock-Fill Dam

Study of Experience with Rock-Fill Dams Justified Use of Steep Slopes and Concrete Facing — Great Spillway Capacity Removes Danger of Overtopping—Novel Closure Device—Large Concrete Plug Valve

A REVIEW of the problems encountered in planning the Dix River Dam of the Kentucky Hydro-Electric Co. was given by the designer of the dam, L. F. Harza, before the American Society of Civil Engineers at its recent Cincinnati meeting. The methods of building the great structure, which is the highest rock-fill dam ever attempted, were described in our issue of April 2, p. 548, but only bare reference was made at that time to the many interesting engineering features of the dam.

Ceneral Form of Dam—While rock-fill dams, though used extensively in the West, have remained foreign to the eastern half of the country, the Dix River enterprise presented conditions which either prevented or made undesirable the adoption of any other type. The width of the valley was considered too large for advantageous use of a single arch dam, and the proposed storage height (about 240 ft.) was believed to be so far beyond precedent in multiple-arch construction as to make it prudent not to consider this type. Material for hydraulic-fill construction was not available at the site of the dam. Something cheaper than the gravity type of dam was desired. In the early stages of the enterprise it was planned to develop initially only part of the head, the dam to be raised to full height later; under this condition a rock-fill dam was considered as lending itself well to increase of height without involving great extra expense in the initial construction. But even after it was decided to develop the full head from the start, the rock-fill type still was found to be the most suitable. The great storage height proposed was a factor in the conclusion, as it was thought that because of its inherent stability the rock-fill dam would involve less risk in an increase of height beyond prior practice than any other type.

Fig. 1 gives the dimensions and form of the structure and the principal features of its upstream face protection. The main design problems subsequent to the decision in favor of the rock-fill type were centered in this face protection. The dam itself was planned and built simply as a miscellaneous fill of rock of random size as excavated, placed substantially to maximum slope, and requiring no study of stability in view of the well-established resistance of such structures to displacement or distortion by water pressure.

A dense, non-crystalline limestone free from fossils is the material of the dam. It was found to have an absorption of only 0.079 per cent, while its crushing strength ranged from 12,500 to 15,000 lb. per sq.in.

The downstream slope of the dam is 1 on 1.4, slightly flatter than the natural slope resulting when the material is dumped over the top of a high slope, which is 1 on 1.3, approximately. When carefully placed the material will stand at steeper slope, however, and accordingly the upstream face is built to a slope of 1 on 1.2 at the bottom, changing to 1 on 1 at the top.

In order to make the dam substantially watertight, the upstream face is covered with a concrete paving. This pavement rests on a tightly laid dry rubble slope-wall placed directly on the rock fill, with a thickness ranging from 14 ft. at the base of the dam to about 7 ft. at normal water level.

Design of Facing—The rubble slope-wall, built of large stones, ranging from 3 to 8 tons in weight, random laid, thoroughly chinked and wedged with spalls, is expected to stabilize the face of the dam and smooth out the settlement considerably. Nevertheless it was thought that local settlements of considerable amount might occur, and the first design of the concrete pavement, therefore, provided for laying it in 8-ft. squares, articulated at the joints to transmit shear and yet give complete flexibility. A study of existing rock-fill dams showed, however, that such local settlements do not occur. Mr. Harza plotted the crest settlements of the Swift dam, near Valier, Mont., which is 160 ft. high above stream bed and 190 ft. above foundation rock, in the curve reproduced in Fig. 2, which reveals no local irregularities exceeding 0.3 ft., although the maximum settlement at midlength is 2¾ ft. Similar observations made at other high rock-fill dams indicated that the proposed extreme subdivision of the paving slab was unnecessary, and showed that the settlement might be expected to occur in an evenly distributed manner, genrally proportional to the depth of fill at the point in question, so that only general flexure of the facing slab needed to be provided for.

Accordingly, the slab was studied as a continuous membrane or pavement, and while it was divided into rectangular panels 48x70 ft., by expansion joints, running down the slope and horizontally, these were provided for expansion and contraction rather than to give flexibility. Mr. Harza says:

Our slab is so designed that a general deflection of the entire face of the dam, considered as a beam uniformly

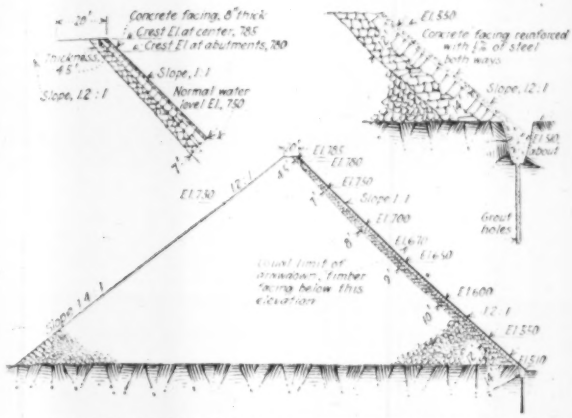

Concrete facing, 8" thick
Crest El at center, 785
Crest El at abutments, 780
Slope, 1:1
Normal water level El. 750
Slope, 1.2:1
Concrete facing reinforced with ½% of steel both ways
Slope, 1.2:1
Grout holes
Slope 1.4:1
Limit of excavation; timber facing below this elevation

FIG. 1—HIGH ROCK-FILL DAM OVER DIX RIVER—RUBBLE, CONCRETE AND TIMBER FACING ON UPSTREAM SIDE

loaded, to the maximum amount of 10 ft. near the upstream heel, where the depth of fill is small, and increasing to a deflection of 102 ft. at the crest, where the depth of fill is about 275 ft., could safely occur without exceeding safe unit stresses in the slab, and local settlement in individual panels between the expansion joints spaced 48 ft. apart could occur to the extent of 1.73 in. near the bottom, increasing to 3.5 in. near the top, for normal working stresses in concrete and steel, and about three times this amount before failure of either. . . It is, therefore, believed that the flexibility of the concrete facing will be ample to accommodate any prospective settlement without exceeding safe unit stresses, either in steel or in concrete, and without resultant cracking and leakage of the facing slab.

The slab as built is 18 in. thick at the bottom and 8 in. thick at the top. It is reinforced with 0.5 per cent steel in each direction, located in the middle of the slab. The concrete was proportioned for a strength of 3,000 lb. per square inch in 28 days and was thoroughly tamped under top forms, which were built up not more than 1 to 4 planks (10 to 40 in.) above the concrete.

At the expansion joints, the abutting slabs rest on concrete ribs formed in grooves built in the slope-wall, and are joined to the ribs by U-shaped copper seal strips, above which the joint is filled with compressed cork. These ribs are 48 ft. apart horizontally and 70 ft. up and down the slope.

Timber Surfacing—As a further safeguard in the matter of water-tightness, the top forms of the concrete slabs were left in place, for the lower 160 ft. of height of the dam. Since the reservoir is intended for power use, it will not be drawn down below this

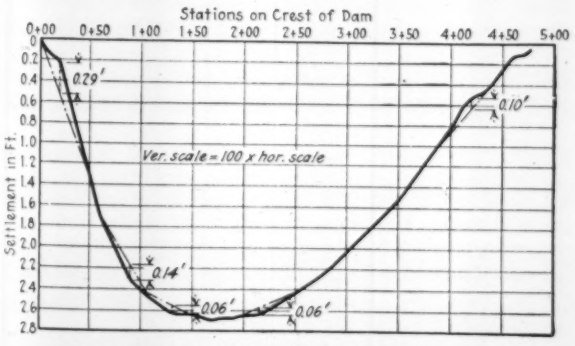


FIG. 2—CREST SETTLEMENT OF SWIFT DAM (AFTER NINE YEARS' SERVICE)

elevation while the plant is in operation, and the dam thus is in a different condition from storage dams for irrigation or water-supply purposes, which can be inspected from time to time by draining the reservoir. Since an upper form was necessary in any event for pouring the pavement slab, it was decided to build the form carefully and leave it in place permanently on the concrete, as an additional seal. Well-seasoned 3x10 yellow pine lumber, tongued and grooved, was used for the form. It was laid rough side down and bolted into the concrete. It is believed by the designers that this sheathing will swell to form a very tight diaphragm, as permanent or more so under water as the

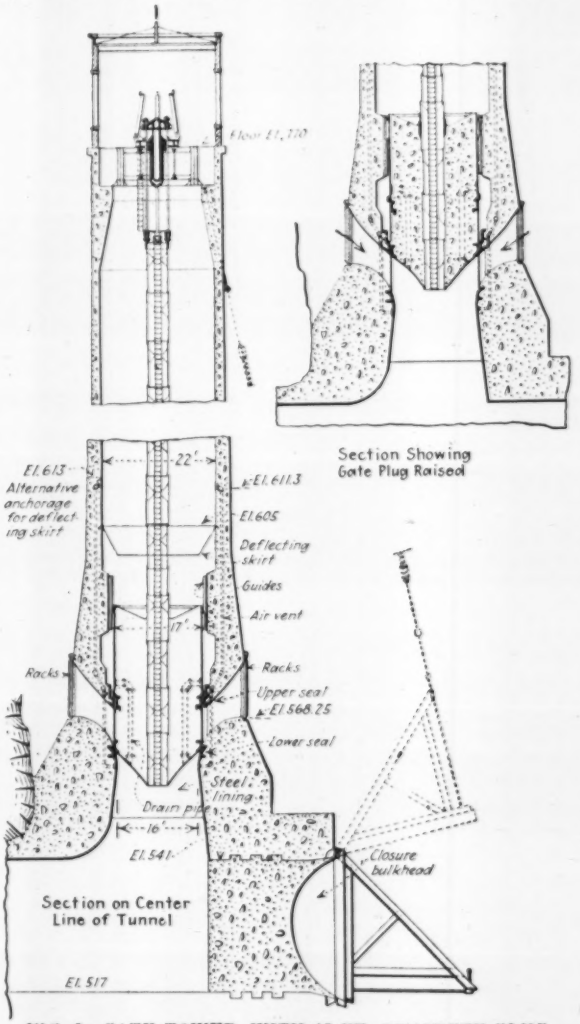


FIG. 3—GATE TOWER, WITH 17-FT. CONCRETE PLUG VALVE AND HEMISPHERICAL FLOOD GATE FOR TUNNEL CLOSURE

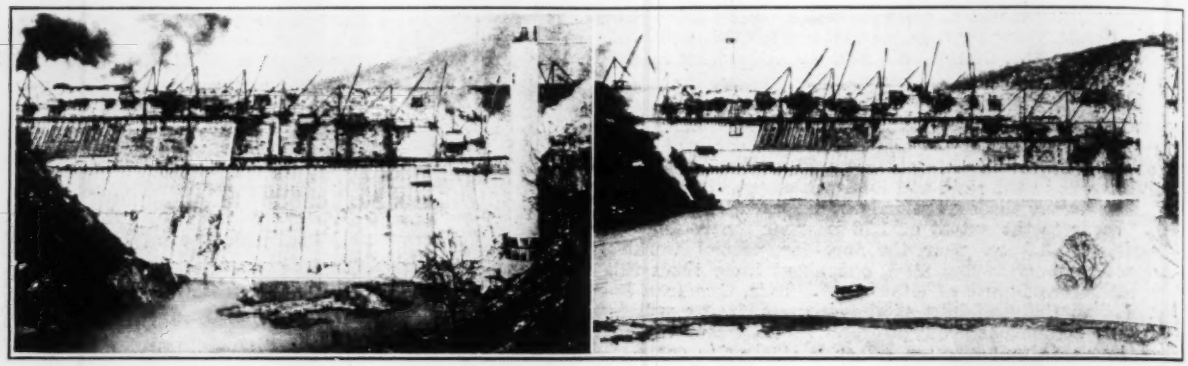
concrete itself, and that it will form the first line of defense against seepage through the facing slab.

Each rectangle of the slab was poured continuously, as it was desired to have no construction joints except at the expansion joints.

Spillway—Ample spillway capacity was known to be vital. By locating the spillway in a rock cut through the hill on one side of the dam, and by utilizing the spillway excavation as the main material supply for the body of the dam, a very great spillway capacity

resulted. The channel has a capacity of 200,000 sec.-ft. or about 500 sec.-ft. per square mile of the drainage area (412 square miles), which is equal to a runoff rate of 18.75 in. depth per day from the entire drainage area. The maximum recorded flood of the Dix River within a record period of 13 years, however, is only about 28,000 sec.-ft., or 70 sec.-ft. per square mile.

Grouting—Three-inch grout holes of varying depths were drilled through the cutoff wall. The first series, Series A, were drilled 40 ft. apart, each hole being tested with water pressure and then grouted as soon as drilled. These first holes were drilled about 200 to 250 ft. deep, and the tests on them were used as a guide in determining the depths of subsequent holes. The second, or B, series, were drilled midway between the A holes; the C series midway between A and B, and the D series where needed midway between the B and C. The holes showed non-cavernous, fairly solid rock, containing occasional seams as in any rock foundation.



FIGS. 4 AND 5—RESERVOIR BEHIND DIX DAM ON DAY OF CLOSURE (MARCH 17) AND TEN DAYS LATER

Outlet Tunnel and Tower—A tunnel through the side hill served for stream diversion during construction and will be used in part as a pressure tunnel to supply the turbines. The size was determined by the flood to be passed. Its section is 24x24 ft., horseshoe shaped, with unreinforced concrete lining; the high rock cover, nowhere less than 100 ft., was considered sufficient assurance against fracture and leakage of the lining.

To provide for control of the supply to the turbines, an intake tower is built over the concrete prolongation of the tunnel above the upstream face of the cliff; the concrete base of the tower is extended far enough upstream to provide for a portal, bulkhead, and permanent concrete sealing plug of the diversion, the intake shaft through the tower entering the tunnel just below the closure plug. The tower is a circular reinforced-concrete structure 22 ft. in diameter inside, but reduced to 17 ft. at the plug-valve seat near the base. Here a series of 12 ports is provided to admit water from the outside, passing downward to the 17-ft. shaft, arranged to be controlled by a huge concrete plug valve. The construction is clearly shown in Fig. 3. The plug of the valve is 17 ft. in diameter by 30 ft. high, and consists of a steel shell used as form, cast semi-steel sealing rings and seat rings, and a concrete filling. It moves vertically in a clearance of $\frac{3}{8}$ in. in the tower opening, comes to bearing on a 45-deg. seat at the bottom of the intake ports, and is simultaneously sealed by a compressible seal at the top of the ports. The plug weighs 575 tons, and is proportioned to resist a possible upward reaction of 480 tons, when the intake tower is used to full capacity for exhausting flood waters into the tunnel with full reservoir, under which condition the gate would pass about 16,000 sec.-ft., with a discharge through the ports at a velocity of 80 ft. per second.

Support is provided for the plug by a tubular stem consisting of a steel-plate pipe $\frac{3}{8}$ in. in shell thickness, 4 ft. in diameter, extending from the top of the tower down through the plug, and serving not only as stem but also as manhole and air vent to the tunnel. At the top, this stem is engaged by an oil pressure hoist, supplied by a motor-driven pump giving a normal pressure of 3,700 lb. per sq.in., which can lift the plug at the rate of 2 in. per minute (total lift, 76 in.). A small filling valve is also operated from the room at the top of the tower. A suspension bridge gives access to the tower.

Exhausting the flood water through the gate tower was provided for as a safeguard in connection with the plan to begin impounding water in the reservoir before completion of the dam. The low flow of the river would otherwise result in considerable loss of time between completion of the dam and actual delivery of power from the plant. When the construction of the dam is so far advanced that the necessity for flood discharge through the intake tower has passed, three 8-ft. penstocks will be installed in the lower end of the tunnel, extending about 100 ft. in from the portal, where they will be bedded in a concrete plug about 35 ft. long.

Closure of Diversion—It was originally planned to close the diversion in a period of low water. The plan was to build a pipe some 6 ft. in diameter into the upper end of the diversion tunnel, with valves at the ends for closing the diversion at the desired time. The pipe would subsequently have been grouted full. This plan had to be abandoned when it became evident, last summer, that closure could not be made before the advent of winter floods, and that it would be necessary to make the closure during the high-water season. This required the development of a method of closure which could be carried out under a large flow through the undiminished portal of the tunnel.

At the same time, it seemed desirable to make some provision for reopening the closure bulkhead or valve later on, in case extreme flood conditions should so far exceed the discharge capacity of the ports in the intake tower that the rising water in the reservoir would threaten to overtop the uncompleted dam.

Fig. 3 indicates the method adopted. A closing bulkhead consisting of a hemispherical flood gate 26 ft. in

diameter at the seat was designed and built. This flood gate, consisting of a cast-steel sectional rim to which was riveted a plate-steel hemisphere, concave upstream, was hinged at its upper side. It was designed to withstand the entire head of water (225 ft.) over the center line of the bulkhead, or a load of about 4,000 tons. A frame serving as handle or lever was built against the upstream face of the valve, with its arm projecting from the lower edge of the valve at right angles to its face. The valve was held up and subsequently lowered by means of a hoist rope attached to the outer end of this lever, which made it possible to keep the valve under control and prevent its slamming to its seat in closing.

For emergency reopening on a 20-ft. diameter circle in the hemispherical plate body there is provided a circumferential double-butt-strap joint, having built into it between the butt straps a ½-in. copper tube. This tube extends out and upward to the top of the adjoining hill; after closure of the valve, the tube could at any time have been filled with nitroglycerine and the central part of the valve shot out, reopening the diversion tunnel for flood discharge. However, on March 17, 1925, the plug valve was lowered to closure, and storage in the reservoir began. Within the following month, and the passing of the early part of the flood season without extreme river stages, the emergency which dictated the reopening provision passed by, so that the feasibility of reopening the diversion tunnel will not have to be demonstrated by practical trial. The tunnel will soon be filled with concrete back of the flood gate, to form a permanent concrete closure plug about 20 ft. long.

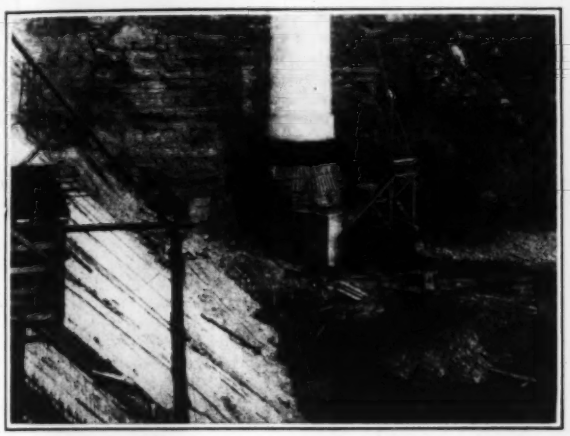


FIG. 6—CLOSURE GATE READY TO BE DROPPED

Drawings accompanying the article of George P. Howson on the construction of the dam in our issue of April 2, p. 548, may be consulted in connection with those shown here. The methods of transporting and placing the rock of the dam fill and the stone and concrete upstream facing were also shown in that article.

The dam was built for the Kentucky Hydro-Electric Co. by the L. E. Myers Co., of Chicago, E. Collins, vice-president and general manager, and A. L. Nelson, superintendent on the work. Mr. Harza had the consulting assistance of Arthur P. Davis, chief engineer of the Bay County's water district and M. M. O'Shaughnessy, city engineer of San Francisco, who approved the design of the dam. Mr. O'Shaughnessy was responsible for the adoption of horizontal expansion joints in the concrete facing. George W. Howson was resident engineer on the work.

Much Road Improvement Under Way in Allegheny County

ROAD improvement aggregating 160 miles is planned by Allegheny County, Pennsylvania. Of the entire program about 100 miles will probably be completed this year. The ultimate cost of the work will be $8,000,000.

Money for this large improvement program was made available a year ago, when the voters of the county approved a bond issue of 29 million dollars for public improvements, of which 8 millions was allotted to road improvement as follows:

Construction of new county highways	$4,050,000
Reconstruction and widening of existing roads	1,162,000
Joint road improvements with boroughs and townships	1,088,000
Elimination of railroad grade crossings	800,000
Elimination and improvement of dangerous curves	500,000
Erection of safety barriers on public highways	400,000
	$8,000,000

The expenditure of these funds is in the hands of the board of county commissioners, through its department of public works. J. G. Armstrong is chairman of the Board. Norman F. Brown is director and Charles M. Reppert assistant director of the department.

The location of new roads in Allegheny County is recommended by the County Planning Commission, which consists of nine men residing in different sections of the county who serve without compensation, and which weighs both the practical and theoretical elements that affect the selection of road locations. A group of thirty engineers, under the leadership of E. L. Schmidt, which makes surveys and estimates of proposed new roads, furnishes the commission the technical data on the project. In addition, public hearings are held before the commission so that all groups of citizens interested in particular roads may express their views on the subject.

The commission also has had prepared a major road plan of the county, which represents the results of a comprehensive, high-plane viewpoint on the road system as a mechanism of communication and circulation of traffic, both as it exists today and as it is destined to exist in the future. With these data as a background; with the technical data on grades, alignments and costs submitted by the engineers, and with the intensely practical views and information developed in the public hearings, the commission is in a position to make well-balanced recommendations to the County Commissioners for priority consideration and final approval.

Included in the 160-mile program mentioned are new roads, reconstruction and widening of existing roads, curve and railroad grade crossing eliminations and state highway projects; also about 65 miles of road surfacing, which will be carried out by the road maintenance division of the Department of Public Works of the county.

Federal Aid for Drainage to Be Requested

Under a bill signed recently by Governor Baker, of Missouri, it is planned to request Congress to pass an act permitting the Department of the Interior to take part in the reclamation by levees and drainage of about 3,000,000 acres of swamp land in the southeastern part of the state. A commission to be appointed by the governor and to co-operate with an Arkansas commission and federal officials will study the flood conditions.

Wood-Grating in Filters and Cemented-Gravel Layer

Symposium by Five Engineers Giving Facts and Opinions Based on Experience and Observation at Various Test and Working Scale Plants

Corroborates Some Doubts Raised by Milwaukee Experiments

BY J. W. ELLMS
Engineer of Water Purification and Sewage Disposal, Cleveland, Ohio

THE conditions affecting the hydraulics of rapid-sand filter-underdrain systems are always of interest to engineers, and H. N. Jenks' paper on the wood-grating underdrains of the Sacramento filter plant in *Engineering News-Record*, April 16, 1925, p. 634, is a valuable contribution on this subject. The writer can claim only a little experience with this type of underdrains, but such as he has had leads him to believe that the statement made in the Report of the Experiments on the Purification of the Water Supply of Milwaukee by him was practically correct.

The experimental filter used at Milwaukee had an area of about 22 sq.ft. The space under the grid was 6½ in. deep. Into this space the wash-water was discharged through a 4-in. pipe with a tee on the end of the pipe. The effect of the tee was to shoot the water horizontally toward the sides of the chamber. The grid consisted of 1x6-in. boards set on edge and spaced 1 in. apart. The open area of the system was, therefore, 50 per cent of the total sand area.

It was unfortunate that a rate of wash had to be used that did not go above a vertical rise of 21 in. per minute at the beginning of the wash, and which often fell as low as 16 in. per minute toward the end of the wash. Nevertheless, the sand bed was always floated and good washing effects were obtained. The conclusions drawn from the operation of this type of underdrain system as stated in the report are as follows:

"In spite of the absence of trouble with this form of strainer, it is believed that had there been available a wash-water pressure which was capable of producing an upward velocity of 2 to 2.5 ft. per minute, the bed might have been "blown up" and ruined. What has not been established is the necessary depth of the gravel layer below the sand which will prevent a hole being blown through the gravel, thereby disrupting the bed. If high velocities through the gravel can be properly controlled by a sufficient depth and by proper grading of the gravel, it is believed that the grid will furnish a comparatively cheap, simple and effective type of strainer. Further experiments for the purpose of establishing the truth or falsity of the points noted above are necessary before it could be safely adopted for use in a large plant."

Mr. Jenks' experience with large filter units corroborates in a measure the doubts raised in the foregoing conclusion. It also to some extent confirms the disastrous results obtained in the first attempt to wash the large 12-m.g.d. filter units of the Louisville, Ky., plant as first designed and constructed. (See *Engineering Record*, Jan. 5 and 19, 1901, for original design, and June 1, 1912, p. 592, for the reconstruction.) In these filters the underdrain system consisted of two layers of wire cloth laid one above the other. Just what the area of openings was as compared with the total sand area of the filter bed is not known by the writer, but it must have been quite large.

There is little doubt in the writer's mind that air and water combined in the Sacramento filters would produce the violent eruptive effects described, and that the stratification of the gravel layers would be ruined as a result. Once these layers of gravel have been moved, it must produce wide variations in the frictional resistance offered by the gravel and sand, and consequent disruptions of the bed at points of least resistance.

It would appear to the writer that unless very low velocities are produced in the main channel before entering the separate water ways, and that, unless even in the latter the velocity head is negligible, uneven washing must result. Assuming that a minimum of velocity is effected throughout the space underneath the entire grid system, inequalities of flow must result the moment the water begins to pass up through the gravel and sand. Points of least resistance will thus become the channels of greatest flow.

The use of a cemented-gravel layer, even if reinforced to withstand pressure inequalities, seems to the writer to be seeking for a solution of the problem in the wrong direction. The easiest place to control the velocity head is in the strainer system and not in the gravel layer. A gravel layer only 13 in. in depth in the Sacramento filters seems to the writer far too shallow when using a grid system. Even with a perforated-pipe system, it is the writer's practice to use from 18 to 21 in. of gravel. The lower layers should be of fairly large size with a fairly uniform grading upward to the finer gravel at the top.

Without doubt a delicate hydraulic equilibrium must be established in the grid type of strainer system, if it is going to operate successfully. The question in the writer's mind is, whether the means necessary to establish such an equilibrium in design, and the exigencies that arise from improper operation of such a system are worth the effort, when other types of strainer systems have proved their efficiency and practicability.

* * *

Metal Distributors More Dependable Than Gravel

BY WELLINGTON DONALDSON
With Fuller & McClintock, Consulting Engineers, New York City

THE departure of Baltimore and Sacramento from the conventional type of filter underdrain in general use during the preceding decade has been followed with much interest by those having to do with filter design and operation. This interest has been friendly instead of hostile because the new style of underdrain, if successful, has clearly outstanding advantages in the way of simplicity, ease of installation and construction cost. It would mean that the construction of filter underdrains would be taken away from the foundry and machine shop and given over to the carpenter.

While waiting for the results of a practical trial of the new underdrain, such as has been made available by Mr. Jenks, doubt has been expressed from various quarters as to the wisdom of discarding the older method of distributing wash-water by means of orifices in metal pipes or strainers and relying upon the comparatively light resistance of a carefully graded gravel bed to secure uniform distribution of the wash-water. It was felt by some that even if the carefully graded gravel bed could be built so as to give a uniform distribution, the later development of areas or passages of less resistance than afforded by the bed as a whole would result in a cumulative tendency of the wash-water to pass more readily through certain portions of the bed than others. Such views were expressed by Ellms, Daily and Metcalf in a discussion of the Baltimore experiences in *Engineering News-Record*, April 3, 1924, p. 563. The writer shares these views and believes that "metal" distribution is more dependable than "gravel" distribution. The gravel layer was first incorporated in filter design simply as a trap against sand entering the underdrains. Subsequent additions of graded layers of coarse gravel were for the purpose of combatting jet action incident to the use of larger orifices than the old strainers had. Apparently little consideration in this development was given to the possible function of the gravel as a wash-water distributing device.

One underlying reason in the writer's mind for favoring "metal" distribution has been the observed behavior of a number of filter installations embracing various types of underdrains. In the case of the once popular underdrain consisting of brass strainers screwed into the tops of iron lateral pipes there was a well recognized tendency of the end strainers to become progressively clogged resulting in unequal wash with its various attendant ills, such as banking of sand, dead areas and deep cracks. Even with the more modern type, consisting of perforated pipe or of strainers in a false bottom, it requires stoppage of only a few adjacent holes or strainers to produce poorly washed areas in the sand bed in spite of an adequate gravel layer and a comparatively high-velocity wash.

The Sacramento experience with wooden underdrains, as related by Mr. Jenks, seem to support the fears above expressed as to what might be expected in the absence of orifice distribution. The results are covered very well in his term "hydraulic instability," due to the slight resistance of the gravel layer. If, in order to make up for the shortcomings of this arrangement, it becomes necessary to install a different kind of orifice device consisting of a thick layer of loosely cemented gravel, and if further it becomes necessary to reinforce this layer with steel rods in order to secure it from failure as a slab, then this type of underdrain loses its principal attractiveness, which is simplicity and low cost. It is in a way attempting to do something which can with more certainty and reliability be done by multiple orifices of definite size in metal and definitely spaced over the bed area.

If porous slabs of cemented gravel are to be used it would seem more logical to anchor these slabs directly over the supporting false bottom and use over the gravel slab only a shallow layer of finer gravel as a trap against clogging by sand. An objection to the cemented-gravel layer yet to be answered is the possibility of its becoming clogged and the inability to overhaul without complete destruction and replacement of the slab.

Why is a very low resistance in the underdrain system especially to be desired? The additional head required to give orifice distribution is at most only a few feet, which is not sufficient seriously to modify provisions for supplying wash-water even when this water has to be pumped. Would the wash-water tank have to be materially elevated or would the additional head against which the wash-water is pumped constitute a serious item of operating expense?

In regard to the troubles from air entrainment mentioned by Mr. Jenks, it is not easy to see that these are related particularly to the type of underdrain discussed except that a false bottom provides more space for accumulation of air than is the case with underdrains of perforated pipe. In other words, air entrainment is due either to release of dissolved air under tension of the negative head or else to being drawn in through some opening or pipe connection under negative head. Air entrainment is undesirable in any type of filter and is to be combatted at the source rather than by modification of the underdrain.

A fair interpretation of the Sacramento experience is, that while these particular experiments have not been favorable to the type of underdrain discussed, the feasibility of the idea is not necessarily disproved. Nevertheless they indicate what may be expected unless an exceptionally well-graded gravel layer is secured, and unless the inlet arrangements for wash-water are provided in a manner conducive to uniform pressure under the false bottom. The difficulties of meeting these conditions are indicated in Mr. Jenks' statement that such small differences in head as 2 in. between ends of the distributing conduit have given rise to inequalities of wash.

We must remember that the Baltimore experiments with this type of bottom have been carried on for a considerable period with results at variance with those reported at Sacramento. For a correct judgment in this matter we need recent Baltimore observations presented in the light of the Sacramento experiences, so interestingly related by Mr. Jenks.

[Recent information from Baltimore indicates that the one filter equipped with wood-grating is operating as satisfactorily as the remaining filters, as noted in the adjoining discussion by James W. Armstrong.—EDITOR.]

Baltimore Experience With Slat Bottom Type Satisfactory

BY JAMES W. ARMSTRONG
Filtration Engineer at Montebello Filters, Baltimore, Md.

I HAVE more than a passing interest in Mr. Jenks' account of the troubles with the slat-bottom filters at Sacramento, especially as I feel that the remedy is much simpler than the one he has suggested. Mr. Jenks stated that 13 in. of gravel and 34 in. of sand were used, but he did not tell how the gravel was graded. On looking up the Sacramento contract plans and specifications, which I presume were followed literally as Mr. Jenks' other figures agreed with them, I notice that in the four filters with the slat bottoms the gravel was 5 in. less in depth than in the filters where the perforated-pipe laterals were used. The specifications call for the following:

Layer	Screen Diameter or Opening, Inches		Depth of Gravel Layers in Filters 2-4-6-8 Slat Bottom	Depth of Gravel Layers in Filters 1-3-5-7 Perforated Pipe
	Passing	Retained Upon		
First, bottom	2½	1½	3 in.	6 in.
Second	1½	¾	3 in.	4 in.
Third	¾	¼	3 in.	4 in.
Fourth, top	¼	10 Mesh per in. No. 20 Wire	4 in.	4 in.

It will be noted that only a 13-in. depth of gravel was placed in the slat-bottom filters, where the gravel layer alone is relied upon for distributing the wash-water, and that a depth of 18 in. of gravel was placed in the filters with the perforated-pipe laterals, where the wash-water is evenly distributed before reaching the gravel layer. As the top 4 in. of gravel can only be considered as a coarse sand for supporting the finer sand, it only leaves a 9-in. depth of gravel to act as an effective medium of distributing the wash-water, a depth in my judgment not sufficient for the purpose.

I believe that the thin gravel layer in the slat-bottom filters at Sacramento is sufficient explanation of their trouble, and that if the depth of gravel in the two types of filters had been reversed, there might have been no trouble.

One other factor might have entered in slightly. The wash-water is admitted through four 5-in. holes into a narrow and shallow compartment at a velocity of a little over 3 ft. per second, when applied at a rate of 2 ft. vertical rise per minute. This rate would tend to decrease the pressure at the inlet and increase it at the opposite side where the water impinges against the wall. I believe that with a proper depth and grading of gravel there would be no necessity for a cemented-gravel layer as suggested by Mr. Jenks.

It may be of interest to those concerned with the design of filter-strainer systems to review briefly the history of the slat-bottom filters, as far as I am acquainted with it. In the latter part of September, 1918, I visited J. W. Ellms at Cleveland, Ohio, who was at that time about to start an experimental filter plant at Milwaukee. I asked him if he would be willing to equip one of his small experimental filters with slat bottoms and made him a sketch of the way I thought the installation should be made. He said he did not think very much of the idea but would be willing to try it, and he did. His second filter was of the perforated-pipe type.

In the report of the Milwaukee experiments, which appeared a little more than a year afterward, there was practically no difference in the performance of the two types of filters, but on p. 47 Mr. Ellms summed up his conclusions on the operation of experimental filters as follows:

"The wooden-grid strainer system also gave good results. Toward the end of the work an examination was made of the filtered-water well immediately under the grid in order to see whether sand had worked its way down through the gravel bed. None was found. Examination from above showed the gravel bed to be in good shape also. In spite of the absence of trouble with this form of strainer, it is believed that had there been available a wash-water pressure which was capable of producing an upward velocity of 2 to 2.5 ft. per minute, the bed might have been 'blown up' and ruined. What has not been established, is the

necessary depth of the gravel layer below the sand which will prevent a hole being blown through the gravel, and, thereby, disrupt the bed. If high velocities through the gravel can be properly controlled by a sufficient depth and by proper grading of the gravel, it is believed that the grid will furnish a comparatively cheap, simple and effective type of strainer. Further experiments for the purpose of establishing the truth or falsity of the points noted above are necessary before it could be safely adopted for use in a large plant."

I should not have requested Mr. Ellms to make the experiment in 1918, except for the fact that the city of Baltimore at that particular time was using a large volume of water, and we did not think it advisable to dismantle one of our filters for experimental purposes. As I was not satisfied with Mr. Ellms' report, we decided to use one of our existing filters for the purpose of giving the matter a thorough test. We cut off half of Filter 12 and after removing the strainer plates from the other half, equipped it with wooden slats. The portion equipped had a length of 53½ ft. and a width of 13½ ft. We put about 18 in. of well-graded gravel on top of the slats but on account of the height required for the slats and the extra depth of gravel, it was not possible to use more than 1 ft. of sand.

Wash-water was admitted through four 14-in. pipes, a deflector being placed over the outlet of each pipe. The deflectors were not wide enough to prevent a large volume of water from escaping directly upward against the slats. After placing the gravel, but before placing the sand, wash-water was applied at a rate of 5 ft. vertical rise per minute without disturbing the gravel layer. Afterward air was admitted to the wash-water pipe and underdrains, the tanks were filled with water and then the 24-in. wash-water valve was opened wide. A violent agitation of the filter surface occurred, especially over the inlets where the water rose to a height of about a foot above the surrounding water.

During the year 1923 we were troubled with the growth of organic matter on the sand grains which matted them together to such an extent that it was not possible to pass wash-water through a large area of the filter bed. At the points where the water did break through, it was at an excessively high rate. During this trying period, we had no evidence of the disturbance of the gravel or sand layer of Filter 12. Ultimately we got rid of this trouble by passing the sand through an ejector and sand-washing machine.

In 1924 a new trouble came upon us in the form of a large amount of dissolved air in the water, which was liberated in the sand beds and underdrains as in the case of Sacramento. There was no trouble due to a disturbance of either the gravel or the sand beds. These facts seem to strengthen my belief that the trouble at Sacramento is due to the causes previously stated.

I understand that St. Paul, Minn., built some filters with slat bottoms, but I have no knowledge as to the details of construction or the results of operation. In addition to the filters of this type now being built at Baltimore, a large plant is under construction for Washington, D. C., and the Baltimore & Ohio R.R. Co. recently awarded a contract for a small plant.

After four years of practical operation, part of the time under trying conditions and with only 1 ft. of sand above the gravel and with some undesirable structural features to contend with, we have every reason to believe that filters of the slat-bottom type are a thorough success and should no longer be considered as experimental.

* * *

Iron Ridge Block Diffusers and Wood Grating Used at St. Paul

By John W. Kelsey
General Superintendent of Water-works,
St. Paul, Minn.

I HAVE read with considerable interest Mr. Armstrong's criticism of the wood grating in the Sacramento filters. At St. Paul iron ridge blocks spaced on 7-ft. centers are used to diffuse the wash-water; that is, the water through the underdrain system comes into contact with the cast-iron ridge blocks through 4-in. risers and then is diffused through ¾-in. horizontal holes in the cast-iron diffusers. The wood grating is of standard size, 1 x 6-in. fir boards, surfaced on all sides. These wood slats are set on edge and give a clear space between them equal to their thickness, which is a little under ¾ in. In supporting them on the cast-iron diffusers, the grating boards are butted and not lapped. Our theory was that this would permit the water under the gravel to have plenty of areaway to assume a uniform pressure. The resistance that the water meets in passing through the gravel equalizes the pressure at all points beneath it, which we believed would give a uniform wash.

The gravel is 16 in. thick and the sand 27 in. The gravel is graded from ½ in. to 2 in. Each filter bed has a rated capacity based on 125 m.g.d. per acre of 3,500,000 gal. These filters, twelve in number, were put into service May 16, 1923. They have proved satisfactory and have been inspected by various engineers and filter operators from other cities, who endorse them as giving a uniform and satisfactory wash, with a rate of wash of 2 ft. vertical rise per minute. We have had no occasion to remove the sand or gravel and, therefore, have not been in position to inspect the condition of the filters or underdrain systems. Perhaps it would have been better to have used cypress instead of fir, but the cost was a great deal more. To date we have had absolutely no trouble in any way with the filters, and are, therefore, well pleased with the design.

This plant was designed by myself and L. N. Thompson, senior assistant engineer.

* * *

Cemented Gravel Slabs Satisfactory at Toronto and Elsewhere

By William Gore
Consulting Engineer, Toronto, Ont.

OPEN-BOTTOMED filters of which the wood grating, as described by Harry N. Jenks in *Engineering News-Record*, is a type, have never been adopted in the writer's practice, although its possibilities have been discussed from time to time, perhaps every time when cemented-gravel underdrains have been under consideration. To what extent the cemented gravel in practice would do away with the orifice restrictions we do not know but we have never had the courage to launch out without these restrictions. With drifting-sand filters, using loose gravel covering perforated-pipe underdrains, it was found that the gravel crept up the corners and sides of the filters and interfered with the working of the sand extractors, so that the adoption of cemented gravel by us came as a necessity and its success was such that we now use it in all mechanical filters combined with perforated pipes.

Cemented gravel in the form of slabs over channels forming the underdrain system of slow sand filters was in use many years ago at the works of the Companie General Des Eaux at Choisy le Roi, Paris, France, and the writer experimented at these works with the cemented gravel in a mechanical filter with perfectly satisfactory results. About eight years ago the same system was adopted at Ottawa, Ontario, and shortly after by Toronto and other places. In only one case, which was in South America, has the cemented gravel bed been known to be broken and this was under circumstances which appeared to indicate jolting of the filter, a process which cannot be too strongly deprecated.

An examination, recently, of a cemented gravel bed at Toronto disclosed the unexpected fact that the cement was being slowly dissolved by the water so that the bed, although sound, was more open than when placed, six years earlier. In this case limestone, amidst the more durable materials, may have contributed to the result. Our early fear was that the cemented gravel might tend to choke but experience shows that the reverse is the case. In the early examples the proportion of cement to gravel was 1 to 15 but this has now been increased to 1 to 12 and we have no fear now with higher proportions of cement.

The gravel used has been of clean, rounded pebbles which have passed through a sieve of three meshes, lineal, per inch and has been caught on one with five meshes per inch. After mixing in a machine with sufficient water to compact it, this mixture has been placed in a firmly rammed layer, 6 in. thick in one piece over the whole surface of the filter or filter compartment. The top is rammed but not rubbed. It is left with a relatively smooth, mottled

surface which, after setting, can be swept with a broom without injury. The cemented gravel rests upon a layer of loose gravel covering the perforated-pipe underdrains and is covered with 2 in. of coarse sand, caught on a sieve of 16 meshes per inch. Experience shows that this coarse layer of sand is an essential element in the design. It remains in place and the cemented gravel remains relatively free from the materials which choke up the upper layers of the sand bed.

In backwashing, whether with loose or cemented gravel, it is our practice to start very slowly, gradually increasing to full rate at about one-half the period of washing, then continue at this maximum rate—which is secured by a stopped gate—till the water in the filter begins to clear, when the rate is gently lowered to zero.

This arrangement has been found to be simple and entirely satisfactory. It was determined in the first instance by experiments on a filter with glass sides. The motions in sand while being backwashed are exceedingly complicated and must be seen to be fully appreciated. There are local uprushes of sand and water rapidly changing in form and place accompanied by slower and more widespread settlements. Horizontal zoning takes place with different grades of sand in each zone.

The trouble Mr. Jenks experienced from gas is not an uncommon one. It appears to accompany filtration when the raw water is saturated or nearly so. The gas is then withdrawn from the water by adsorption in the same way as colloidal materials are also withdrawn. If water has just been released from pressure the trouble is usually augmented. This phenomenon has also been studied in glass filters and it is found that the whole bed may become full of dry spots without the presence of negative head, and the bubbles rise from all depths of the filter as well as from the underdrains. We know of no method of stopping the trouble except more frequent backwashing.

Railway Trestle Practice in Queensland

Special Correspondence

A TYPICAL railway trestle used on the 3 ft. 6 in. government railways of Queensland, Australia, is shown by the adjoining view. It is built of eucalyptus, a hardwood abundant in Australia in many varieties. The eucalyptus furnish strong and lasting bridge timber for bridges. In calculating the moment of resistance of girders, a working unit stress of 2,800 lb. per sq.in. may safely be used.

Bridges such as the one pictured will stand for twelve years without giving the maintenance branch any anxiety, and the writer has dismantled similar bridges 35 years old that showed little trace of decay. These figures do not apply indiscriminately to all the eucalyptus, nor to all districts in Australia.

The track construction of the bridge shown consists of rails spiked direct to 9x4½-in. hewn ties or "transoms," 7 ft. 6 in. long, which are close-spaced and are in turn spiked to the 17-in. round dressed girders.

For spans of 12 and 14 ft. c. to c. of bents two girders are provided. As the girders are 5 ft. 6 in. apart, and the gage of the road is 3 ft. 6 in., the transoms are subjected to a bending moment, whose maximum is under the rail at a cross-section weakened by 2⅞-in. holes for dogspikes. For spans of 16 and 18 ft. a third (central) girder is provided. Longer spans (when used) have girders doubled vertically.

The corbels shown over the bents, under the butt-joints of the girders, are an interesting survival of the days when strength of girders could not be calculated. The writer has been informed that they are intended to lessen the span and to lessen deflection.

The bents are generally of three piles each, outside piles raked 1 in 8, but the highest shown has four. The cap consists of two 9x6-in. hewn pieces 10 ft. long, bolted heart to heart, and mortised to receive tenons cut on the heads of the piles. The bridge is liberally supplied with holding-down bolts.

Piles are driven when circumstances permit, but are generally silled at a depth of 10 ft. The sill is an enormous timber, of least diameter 17 in. and of length equal to 10 ft. plus one-fourth height from sill to cap, and it rests on 6 in. of 1:9 concrete and is embedded in it. The outside piles are further bolted down to the sills.

The large amount of holding down is judged necessary on account of the sporadic heavy rainfall to which most Queensland waterways are subject. In the morning, after a fall of 3 or 4 in. during the night (no unusual occurrence), bridges are found with debris piled sometimes over the rails, while the stream may be nearly dry again.

Bridges of the type shown are presumed to be designed to carry an engine of 58½ tons weight, distributed thus: 12,880 lb. (5 ft. 10 in.), 12,880 lb. (4 ft. 5 in.), 26,880

TRESTLE ON GOVERNMENT NARROW-GAGE RAILWAY, QUEENSLAND, AUSTRALIA

lb. (5 ft.), 26,880 lb. (5 ft.), 26,880 lb. (4 ft. 3 in.), 12,320 lb. (5 ft.) 12,320 lb. The writer has no taste for calculations which can be avoided, but some younger engineers might find an interest in investigating such questions as the strength of the transoms in two- and three-girder bridges, the relative strengths of transoms and girders, the effect of the corbels when the bolts securing them to the girders have not been screwed up for three dry years, and the unit pressure under footings. The weight of the timber may be taken at 65 lb. per cu.ft.

The cost of these structures varies in different localities, but average costs are:

Hewn transoms, braces, etc.	$1.80 per cu.ft.
Girders and corbels	1.68 per lin.ft.
Piles	1.26 per lin.ft.
Sills	1.38 per lin.ft.
Concrete for sills, 1:3:6	17.28 per cu.yd.
Wrought iron	0.14 per lb.

Parts of the structure are painted with a fifty-fifty mixture of white lead and white zinc, and part with red oxide paint, at a cost of 48c. per sq.yd., three coats.

Since 1917, all railway construction work has been carried out exclusively by day labor under the government's own engineers. A cumbersome and costly system has been built up, under which the engineers have practicaly no control of the labor employed. All rates of wages are determined by a bewigged judge of an Arbitration Court, and many "disputes" such as arise when the engineer's directions do not meet with the approval of the gangs are solemnly investigated by an Industrial Magistrate. This sounds like comic opera or Munchausenisms, but it all is what Mark Twain once described as "the frozen truth."

Engineering in the Small City

A series of notes from the field on the Problems and Practices of the Municipal Engineer in the Cities Below 100,000

The Editor Visits the City Engineer

Snapshots of Our Representative Small Cities

Cairo, Ill.

LEVEE GATE, CAIRO, ILL.

COUNTY SEAT OF ALEXANDER COUNTY, the southernmost point of Illinois, at the junction of the Ohio and Mississippi Rivers, situated on a low, flat terrain behind levees where the flood waters from 916,700 sq.mi. of upland country flow by. Located at the southern end of the Meridian Highway. Strategic point of a break in freight rate for water and rail. Forwarding point for grain, lumber, cotton and tobacco. Hardwood products are the chief manufacturing interests. Gannister, kaolins, yellow ochre and cementing gravels are a few of the forty natural products of the county. Inhabited since 1750, but chartered as a privately owned enterprise in 1818, it was not a free city with right to govern itself until 1857. From 1818 to 1854 no resident owned a foot of ground. Population 1922, 17,000.

WHEN Charles Dickens visited Cairo and other cities in 1842 on his American trip as secretary to a group of English capitalists he was not particularly complimentary of any city. Going by steamboat from Cincinnati to St. Louis down the Ohio and up the Mississippi he was not much impressed with any of the bank scenery and proclaims in his *American Notes*, "Cairo is a spot so much more desolate than any we had yet beheld, that the forlornest places we had passed were, in comparison with it, full of interest." Perhaps the lamentations of the bankers he was accompanying whose money had been sunk in the promotion of this privately owned enterprise, a scheme enriching the promoters only, had an undue influence on Dickens' mind. That was 83 years ago, but Dickens' description of the location and obstacles with which the engineer had to contend is necessary to give proper background for the Cairo of today. Looking at it now we might say that almond-shaped Cairo lies snug between levees like a nut in a curved cracker. But let Dickens picture the location:

"At the junction of the two rivers, on ground so flat and low and marshy that at certain seasons of the year it is inundated to the house-top, lies a breeding-place of fever, ague, and death; vaunted in England as a mine of Golden Hope, and speculated in, on the faith of monstrous representations, to many people's ruin. A dismal swamp, on which the half-built houses rot away; cleared here and there for the space of a few yards; and teeming, then, with rank unwholesome vegetation, in whose baleful shade the wretched wanderers who are tempted hither, droop, and die, and lay their bones; the hateful Mississippi circling and eddying before it, and turning off upon its southern course a slimy monster hideous to behold; a hotbed of disease, an ugly sepulcher, a grave uncheered by any gleam of promise; a place without one single quality, in earth or air or water, to commend it: such is this dismal Cairo."

Was there ever a more tempting problem to solve by the hardy pioneering engineer of that or any other day? So hopeless it seemed, yet George F. Dewey, present incumbent of the city engineer's office, says flood water has not been in the city since 1858, a bare 16 years after Dickens viewed it. Cairo is completely surrounded by levees which also inclose the Cairo Drainage District. A cross levee carrying railroad tracks at the north city limits separates the two areas. An enormous flood gate in this levee was designed and built by Major C. H. Miller, who lost his life in the Memphis boat-disaster. It spans Sycamore St., the only connection to the north between city and district, so that in event of failure of the levee in one the other may be completely shut off.

Cairo's Low Level—Water, low ground, sand boils, seeps and levees are the principal physical features with which all engineers in Cairo from Dickens' day to this have at times had to contend. First of all the levees themselves had to be raised. When the rivers are up, all structures must rest on a water-logged subsurface. Forever must the remover of earth remember upward pressure when either river is high. Excavation or borrow pit—and earth for levees and to mound up places on which to build must be obtained—is almost sure to become a point of weakness where sand boils develop. Sand boils and seeps are the bane of the levee man's existence, breaking out unexpectedly at the height of a flood when nothing effective can be done. Temporarily, fighters sometimes build a ring of sand bags around the boil and raise the water level so that the infiltration will be reduced below a silt-carrying velocity.

Trenching then, for water, sewer or utilities must be handled carefully, carried on only in low-water periods. Backfilling must be done properly. When excavators encounter tree roots, as they often do, hundreds of years old, all the branch roots which have penetrated the water-bearing sand stratum must be removed. Sand puppies like to eat these roots, which would probably not decay under water. They follow the roots down to water where they hibernate in nests, sometimes 10 ft. across, until the next high water.

It is highly essential that the bottom of excavations be mulched or puddled to break up any direct tubular connections to a water-bearing stratum. Luckily plenty of clay of all kinds is available. In fact, fullers earth, potters clay and kaolins rivaling those of Europe and New Jersey have recently been located in the vicinity of Cairo and find a ready market.

While Cairo has not been under water in 67 years the floods of 1912 and 1913 breached the levee of the Drainage District to the north and cut the town off from land communication for many days. Recognizing the danger, more than a million dollars was raised for levee strengthening and repairs. Of this the railroads gave $368,000; the Drainage Board, $175,000; city, $100,000; U. S. government, $250,000, and state of Illinois, $250,000. Prior to this time about $1,500,000 had been expended by all interests combined. Cairo then has a security investment of $2,500,000.

City Engineering—For handling the engineering of this city (except the water-works) one man is responsible, George F. Dewey, city engineer, who has offices above the principal commission house on Ohio St.

overlooking the wide-paved levee slope down to the floating docks on the Ohio River. Beyond are the green hills of Kentucky and in the foreground the concrete levee wall with its ever mindful stop-plank openings. Dewey is master of the situation. He gazes out over the river with love as well as respect and perhaps at times hate. It is a typical surveyor's office with its pigeonholes for the thousand and one plats which are the surveyor's stock in trade. Dewey knows his business and the townspeople respect his knowledge.

Cairo has a commission form of government. D. M. Kelly is the commissioner of streets and public improvements and Dewey is responsible to Kelly but does all the engineering work there is to do under the other commissioners. For instance, Mike Egan, commissioner of public health and safety, called on him for handling the construction of the 10-ton garbage incinerator which as viewed, and smelled, in May was handling its quota without odor or offense. Every other day service is rendered and lately 4 of the 8 tons of coal formerly used annually is saved by feeding more than half of the garbage collected to hogs of farmers. "A fat horse burns itself but it takes a ton of coal for a skinny one and chicken manure is the hardest stuff to burn," are two bits of practical wisdom the superintendent passed out.

Principally, however, Dewey is concerned, as is every other city engineer, with paving and sewer problems. Novaculite, the natural product of southern Illinois which cements well and makes a good macadam road, has the drawbacks of all macadam under motor traffic. It is used extensively in the side streets of Cairo. A 1-in. covering of rock asphalt has been tried with success recently. Brick covers the principal streets, brick on a concrete base. Some of the old brick that has worn uneven has been patched—rather, evened up effectively with the rock asphalt at slightly over $1 per square yard. Rock asphalt costs $11 per ton in Cairo but so many companies are producing it that the prices are responding to the competition.

Sewers—Troubles with pavement, as they are with the sewers, are bound up largely with the seepage water and boils. During the spring flood stages in the rivers everything has to be pumped over the levees. The operation may suck into the sewers the water-logged silt surrounding them until a large cavity results. The sewer drops into the hole and so does the pavement. Again seeps may so soften the subgrade that the foundation gives way. There is no remedy except to excavate down to the sand strata, fill in with a puddle blanket and replace the sewer.

Much difficulty has been encountered from the manner of operating the drainage pumps. No regulators are provided. Suction is lost and water hammer ensues which tends to collapse the sewers.

Sewers now built, over 30 in. in diameter, are of monolithic concrete. Under this size they are usually of clay pipe. Unusual caution must be taken to make tight joints and the foundations now called for are a slab of concrete on piles. Backfilling must be done carefully, either in layers, if by hand, or by flooding, if by machinery, as is the more recent practice. Deep excavations must settle for a year before pavements are laid.

Since the sewage must be pumped, one naturally would feel some unusual interest in the pumps, but Mr. Dewey dismisses them with little comment. Simply motor-driven centrifugals, which are not automatically controlled, or equipped with remote-control apparatus. Attendants in shifts man the five stations. Lately the lines have been carried through the levee bank and down the outside to regain by siphonic action as much head as possible.

Financing, as in all Illinois cities, is done largely under the special assessment laws of the state whereby costs of benefits and injuries are spread over the areas affected.

Floods and Drainage—In 1922 C. E. Smith, consulting engineer, St. Louis, made an exhaustive report on the flood and drainage problems. In it he brings out that the trouble from seepage and boils comes from water totally different in chemical character from the water in either river. The ground water carries about four times as much solids as the river water. But this ground water, though it may come from a gathering ground miles away, still is influenced greatly as to elevation by the get-away possible into the rivers. Hence river heights affect the ground-water levels but there is always a lag of several days.

Some of Mr. Smith's conclusions are pertinent. While no floods have overtopped Cairo's levees in 67 years, levee work downstream may raise levels at Cairo. Simultaneous flood crests from the tributaries of the Missouri, upper Mississippi and Ohio Rivers have never yet combined at Cairo and the probability, in his opinion, is considered too remote to be given thought. Vigilance in protecting the concave banks along both rivers is absolutely vital to Cairo's existence. Filling low areas to prevent inside slopes from sloughing at flood time as a result of seep water standing against the base is recommended. This is being done gradually. Here and there through the town will be seen one lot or a series of lots in the poorer districts 4 ft. lower than the others. Most streets are up to a so-called minimum grade. To fill all areas inside the city will require 3,150,000 cu.yd. and within the Drainage District another 1,250,000 cu.yd. Mr. Smith recommended that the city buy an electrically-operated suction dredge and pump in material from the Ohio River bars at an estimated cost of 15c. per yard. This has not yet been done. The bars are across the river and a pipe line hung on the Illinois Central bridge would carry the material into town.

Like most city engineers, Mr. Dewey is on good terms with bankers and the big men of the city. A knock after hours, on the side door of the main bank in town was successful in bringing his visitors to the inner office of the president who laid aside his balance sheets for the day and spent nearly two hours in outlining the advantages of the city and Alexander County. One of the things he was most proud of was a cabinet containing forty samples of natural products including gannister, kaolin, yellow ochre and cementing sand for road material. Interested in several utilities he detailed the difficulties of the water company which had offered a few years back to finance a new works if a franchise were forthcoming. None was given but, he said, by the help of chlorine, the old filters and a loyal crew, a potable, safe water is being purveyed. Had the problem been left to the banker and Mr. Dewey, the company would have its franchise or the city would take over the plant. So the day was closed and on the Chicago sleeper reflections painted one more city engineer having the time of his life and succeeding not in money

returns but in filling a place in American small-city life, respected by his fellow townsmen and doing the day's work as it came to him.

Formwork for Large Sewers on Short-Radius Curves

By J. C. Keeley
Engineering Department, City of Paducah, Ky.

A CONVENIENT method of building large monolithic concrete sewers on 50-ft. radius curves was used in Paducah, Ky., in the construction of a $650,000 sewer system completed last year. The sewer is in a 96-in. semi-elliptical section built over standard steel forms, each form section being 5 ft. in length. In constructing the invert the chords on the inside of the curve were made 5 ft. in length to conform to the length of the steel arch forms, the chords on the outside being 5.87 ft. in length. Fig. 1 shows a plan of the invert.

After building the invert for the full length of the curve, the arch forms were unbolted and pulled ahead on a truck provided for this purpose and the forms set up on the curve, the side of each 5-ft. section fitting the inside chord of the invert previously constructed. The form sections were bolted with one or two bolts near the spring line on the inside of the curve and permitted to spread, to accommodate the curvature. After the forms were properly aligned and braced, spacers of wood 2 in. in thickness and of varying length were driven between the sections to keep them apart and to aid in bracing. Sheet metal of triangular shape was then placed over the space between the form sections and tacked down to the wooden spacers. Concrete was then poured.

After sufficient time had elapsed to permit removal, the forms were lowered by means of jacks, mounted on the form truck and the form moved ahead and reassembled on the tangential portion of the sewer. Fig. 1 shows a plan of the arch forms as assembled.

As the centers of the curves were generally inaccessible, the curves were staked out with a transit with chord lengths on the center line such as to give a 5-ft. chord length on the inside of the curve. On a 50-ft. radius curve this center line chord length was 5.43 + ft. The points on the curve were then referenced by means of stakes set radially and at certain offset distances, so that after excavation the points could be set again by the use of a chalk line and tape. Fig. 1 shows the method of staking out the curves.

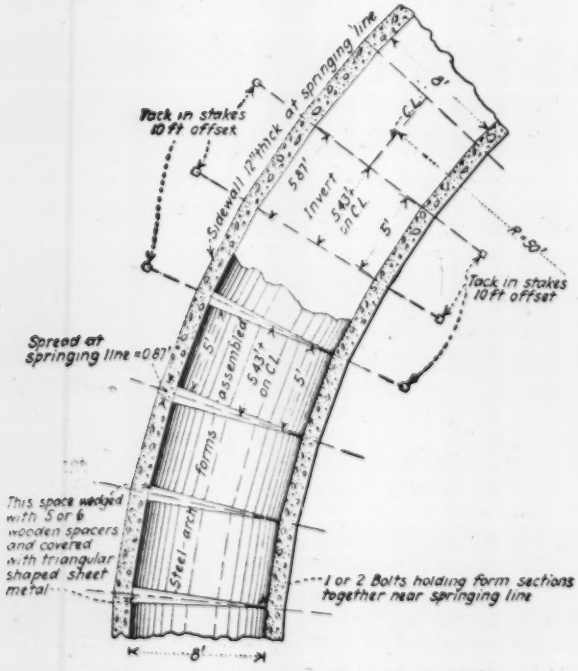


FIG. 1—PLAN OF 96-IN. SEMI-ELLIPTICAL SEWER

Engineering Work

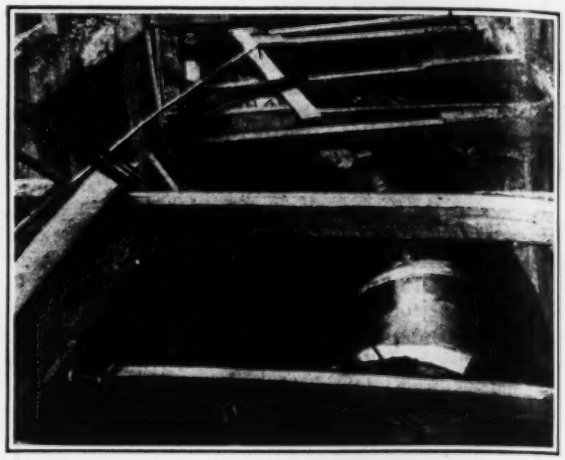
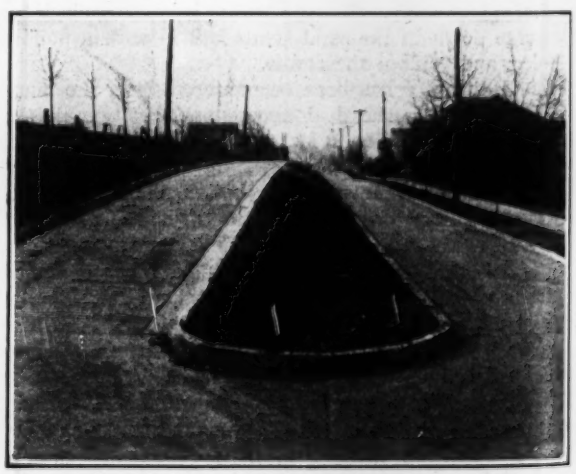


FIG. 2—FORMS IN PLACE ON 50-FT. RADIUS CURVE
The white strips show how triangular sheet metal bridged gap between steel form sections.

Street at Two Levels Serves Sidehill Residence Property

IN LAYING hard surfacing on a section of Denver Ave. from Bellevue to the block overlooking the James River, the city engineering department of Lynchburg, Va., devised a street layout particularly adaptable to sidehill property.

The section of Denver Ave. given this treatment has a difference in elevation between property lines on the two sides of the street from 4 to 12 ft. The street dead ends at the bluff overlooking the James River.



TWO-STRIP PAVEMENT FOR SIDEHILL ST.

Of the Small City

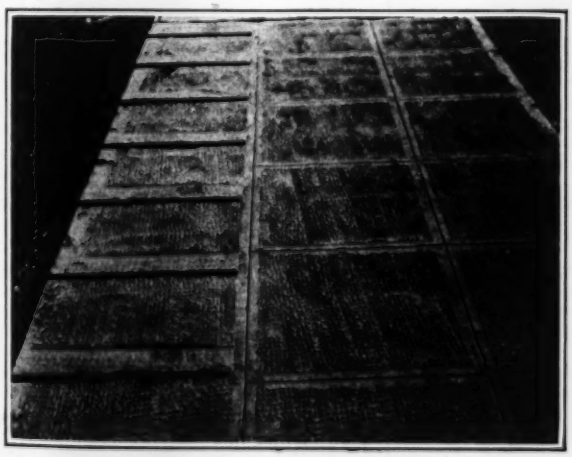
A continuation of the single roadway constructed in the upper section of Denver Ave. would have necessitated a grade line which obviously would be damaging to the property on one side or the other, or possibly both. Therefore, two 12-ft. concrete roadways 475 ft. in length, separated by a 9-ft. wide parkway but connected at each end, were constructed on independent grades. An 18-in. concrete curb and gutter on one side of each pavement slab added virtually that amount to the driveway width. On the upper side granite curbs were placed to support the steep sloping parkway. A short stretch of roadway on a 14 per cent grade was made rough by corrugation of the surface, this as an aid to traffic.

Building Sidewalks to Eliminate Slipperiness and Glare

By William E. Barker
Chicago, Ill.

In *Engineering News-Record* for April 30, 1925, an article appeared describing methods of eliminating glare and slipperiness from concrete walks. For walks which have the nearly obsolete steel trowel finish the acid wash described is effective. There is, however, no reason why new walks should need any such treatment, for they can easily be built with a surface of any desired texture.

The modern concrete walk is usually built in one course, using concrete of the same proportions from top to bottom, instead of having a lean base and a rich mortar top, as was previously the custom. Such a walk is not only stronger than the two-course walk but is also cheaper, because labor costs are less. It was the rich mortar top in the old walk which, when steel troweled, became slippery. The surface of the one-course walk contains more sand and, when a board float is substituted for the steel trowel for finishing, will have a gritty surface which is slip-proof in all weather. This grittiness is increased by using relatively dry concrete and by a final floating after all water has evaporated from the surface.



CONCRETE CLEATS ON STEEP STREETS
Surface roughened by a roller. This street is in Seattle, Wash.

On steep hills or sharply inclined cross walks the concrete may be further roughened to provide a more secure footing in icy weather. This can best be accomplished by "patting" the surface with a wood float. The blow should not be hard enough to make a depression; the result is secured by lifting the float vertically, so that a little mortar is pulled up by the rising board, to form ridges like the mountain ranges of a miniature relief map. On very steep hills concrete cleats may be cast along one edge of the walk for winter walking.

SURFACE ROUGHENED BY PATTING WITH WOOD FLOAT
This is a concrete walk on one of Omaha's steep streets. The pencil shows the size of the elevations.

Light reflected from sidewalks is caused by the light color of concrete. Anything which darkens the concrete will reduce the reflection. The first expedient is to keep the walk wet for at least a week after it is laid. Dark colored concrete may be secured by using dark colored aggregate such as red or black sand and stone.

Darker concrete may also be made by the admixture of various pigments. Only mineral colors should be used. Red iron oxide is the most popular. When two or three pounds is used for each sack of cement the concrete walk will have a delicate and pleasing shade of pink. The additional cost for coloring should not be more than one cent per square foot. About the same quantity of manganese oxide will produce a slate gray walk especially adapted to business districts.

Resurfacing Worn-Out Brick Pavements

Referring to an article in *Engineering News-Record*, June 4, p. 932, on the practice of the city of Jamestown, N. Y., in salvaging old brick pavements, Thomas H. Mather, city engineer of Syracuse, N. Y., has the following to say:

"For the past three years, in resurfacing brick pavements, we have adopted the method of grading the regular surface of the brick pavement with binder and laying thereon a 2-in. top of topeka. This leaves the brick undisturbed and thoroughly compacted under traffic and we have regarded this as the most valuable foundation which we could procure.

"Cortland Ave. was resurfaced in 1922 at a cost of $2.13 per square yard and shows at this date a perfectly smooth surface. In 1924 pavements were laid on five streets at the following costs per square yard: $1.55, $1.65, $1.67, $1.77, and $1.85. We believe we are getting a better top than by relaying brick and at a much less cost."

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Flow Losses in Large Pipes

Sir—The data given by Fred C. Scobey in his article upon Flow of Water in Tulsa 60-in. and 54-in. Concrete Pipe Line in *Engineering News-Record*, May 28, 1925, p. 894, are extremely interesting and significant. Those relating to loss of head in bends are particularly interesting to the writer as a possible confirmation in part of the conclusions summarized by him in an article upon Effect of Curvature upon Flow in Open Channels, *Engineering News-Record*, Sept. 29, 1921, p. 516. While the application of data obtained upon flow in closed pipes under pressure to flow in open channels is uncertain, lack of sufficient data relating to the latter condition is such that it seems desirable to utilize everything which may be significant in this connection.

The conclusion reached by the writer was "that in artificial channels for which the coefficient n in Kutter's formula would not exceed about 0.025 for a straight channel, an addition of from 0.003 to 0.005 should be made to the coefficient for sections in which the amount of curvature is considerable."

The excess loss of head due to curves and bends is probably due largely, if not wholly, to a disturbance in flow conditions by which the thread of maximum velocity is deflected nearer the outside of the curves and the velocities of the filaments in contact with the wetted perimeter in this portion are correspondingly increased as compared with those obtaining when the flow is in straight lines. This probably results in a considerable increase of the average velocity of the filaments in contact with the surface of the conduit and consequently in increased frictional loss, while the mean velocity may remain unchanged. This condition exists in closed conduits as well as open channels. If it were possible to estimate the increase in velocity of the filaments in contact with the surface of the conduit, it might be possible to compute theoretically the increased resistance due to the change in direction, especially if the length of conduit in which the disturbing condition exists could be accurately determined.

The changes in direction in the Tulsa aqueduct being made by bends rather than curves, this theory can be applied only by assuming the distance in which disturbed condition of flow exists. Even if regular curves had been used, however, it would still be necessary to estimate the distance beyond the curve in which disturbed condition of flow exists.

Mr. Scobey shows that the value of n in a section 34,788 ft. long containing 29 bends, was 0.0111, while in a section 80,898 ft. long, classified as slightly sinuous, but containing six bends, the coefficient was 0.0107, an excess of 0.0004 for the section containing a number of bends. If it be assumed that the disturbed condition of flow at each bend extended for 100 ft., then the portion of the section affected by the disturbing conditions was about one-twelfth of the total length and roughly the increase in n in the portion affected by the bends may be taken as 12 times 0.0004 or 0.0048.

If the disturbed condition at each bend be assumed to extend 200 ft., the increase in the value of n would be 0.0024.

Such a method of estimation assumed that increase in frictional loss is directly proportioned to increase in the value of n. Within the limits considered, this is approximately correct as may be shown by computing the value of n for the entire section on the assumption that in the straight portions it may be taken as 0.0107 and in the sections where disturbed flow exists at 0.0155 ($= 0.0107 + 0.0048$). This computation gives n for the entire section as 0.0113, compared with 0.0111 from test data.

This analysis seems to confirm, as far as it goes, the writer's previous estimate of the excess loss of head in bends quoted above.

HARRISON P. EDDY,
Consulting Engineer.

Boston, Mass.
June 5, 1925.

Drains Under Earth Dams

Sir—The failure of the French Landing Dam, as described in *Engineering News-Record*, April 30, 1925, p. 735, leads me to some comparisons between this structure and the earth levees built along the Mississippi and to consider the desirability of attempting to underdrain such embankments.

The French Landing Dam, as described by the designer, Gardner S. Williams, appears to be a bold section when compared to such levees. In a dam over 30 ft. high without core wall, slopes of 2½ and 2 to 1 seem to me to be insufficient when the crown is only 8 ft. wide. On the Mississippi a levee of 30 ft. with an 8-ft. crown would have a base of over 250 ft. against 143 ft. in this dam, and the presence of a berm on the slope would distribute the mass nearer the base. The method of construction would be the same except that the levee would have a cutoff trench along the center line, and while the levee is built of more pervious material on a more or less pervious foundation the water does not stand against it long enough to saturate it as is the case with a dam. I am of the opinion that slopes of 3 to 1 both sides, with an 8-ft. crown, or a 2½ to 1 upstream and 3½ to 1 downstream, without drain pipes, is the least safe section for this dam.

Open drain pipes is an idea borrowed from the inspection galleries of concrete dams and erroneously applied to earthwork structures. Why build a dam to restrain water and then install drains to conduct it through—bringing part of the dam with it? Ordinarily concrete cannot be made seepage proof and there is upward pressure to be cared for, but an earth dam will take care of upthrust itself and drains only aggravate the flow by reducing friction.

The presence of a salient angle in the dam may have been necessary but at this point the ratio of wetted perimeter to mass of dirt was greatest and it was here that the dam failed. Our old friend the line of least resistance.

This with numerous other earth dam failures over the country brings home the fact that this seemingly simple problem in design is not to be dismissed lightly.

ALLEN T. BLYTHE,
Resident Engineer, Yazoo-Mississippi Delta Levee District.

Sherard, Miss.,
June 15, 1925.

[This letter was submitted to Mr. Williams who has replied as follows—EDITOR.]

Sir—Considering separately the two points brought up in Mr. Blythe's letter:

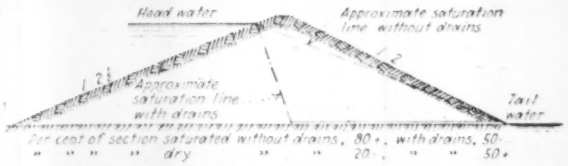
First: As I have had no experience with materials used in levee construction, and appreciate the difference between building a structure to withstand the forces of a rapidly flowing stream, and one designed merely to hold back quiescent water where the only eroding influence is a moderate wave action at the surface, I have never ventured to express an opinion as to the propriety of the accepted designs for the former, but in the light of such experiences as I have had it does seem to me that by properly draining the levee embankments a large reduction in cost with an increase of stability might be secured.

Second: When I developed the drained embankment, and so far as I have been able to discover I am the first one to make use of it, it was not borrowed from the inspection galleries in concrete dams, which at that time were at least not common, but was arrived at as a result of my studies of slow sand filtration, and experiments upon the compacting of earthy materials by the passage of water through them, covering some fifteen years. Several years after I had begun using drains in embankments, the late Frederick P. Stearns, past president of the American Society of Civil Engineers, in discussing with me the construction of his famous North Dike at the Wachussett Reservoir remarked: "Any dam of porous materials is a filter and should be so treated." In the ordinary earthen embankment (see sketch) the line of saturation extends from the upstream water surface to the level of water at the downstream toe of the embankment. If this latter level be at the surface of the ground we have the condition of over 80 per cent of the bank being saturated material and only something less than 20 per cent resting upon it unsaturated. If underdrains be introduced beginning with a header along the center line of the bank and sufficient capacity be provided to carry away the water percolating to it, we then have the same bank with less than 50 per cent saturated and over 50 per cent dry. As the coefficient of friction of

saturated earth is much less than that of dry earth the stability of the bank in the latter condition is seen to be very much greater than it was in the former.

I have been using the drained embankment in all of my hydraulic constructions where embankments were involved for the past fifteen years, with slopes varying from those at French Landing to a 1 on 3 and a 1 on 2½, and all my structures are standing, and the washout at French Landing is the first failure that has occurred on my work, which covers some 35 years of practice.

Several years ago I was called to northern Wisconsin to inspect an embankment constructed wholly of sand, about 35 ft. in height. The water was about 10 ft. below the flow line and the bank was so saturated that the downstream face was sloughing off for a distance of 15 ft. above the


Head water
Approximate saturation line without drains
Approximate saturation line with drains
Tail water
Per cent of section saturated without drains, 80+, with drains, 50-
" " " " dry " " 20- " " 50+

SATURATION CONDITIONS IN DRAINED EARTH EMBANKMENT

toe in places. I immediately had underdrains of V-shaped board troughs—timber being the only material promptly available—worked into the base of the dam as far as it was possible to get them, probably about half way to the center line, and by draining the water out of the downstream portion of the bank restored its stability; the sloughing stopped and inside of sixty days the full head of water was against the bank, and without added material the structure has performed its function for some twelve or thirteen years.

When the water is first raised against a drained embankment the drains usually flow from one-half to three-fourths full, but inside of a week the flow begins to decrease and by the end of a few months, even with the most porous sand, the drains become almost dry.

GARDNER S. WILLIAMS,
Consulting Engineer.

Ann Arbor, Mich.,
June 18, 1925.

Probability Methods for Rainfall and Runoff

Sir—In *Engineering News-Record*, May 28, 1925, p. 906, is a letter from S. L. Moyer, entitled, Probability Methods for Rainfall and Runoff, in which he argues for the propriety of estimating frequency curves for excessive rains or flood flows by using as essential data the maximum rate of rainfall or maximum flood flow in each year of the series covered by the records, omitting all secondary maxima even though they may be materially higher than the maximum for some of the other years.

It seems to the writer that the question relates primarily to what is desired from the probability study. If we merely wish to know in what percentage of the years certain occurrences are likely without reference to the number of times in a year, then the method recommended by Mr. Moyer is appropriate. If, on the other hand, we wish to know the probable total number of occurrences in a given period of years, or, what is the same thing, the average frequency of occurrence, then the omission of secondary maxima in particular years may lead to erroneous results. By including all the floods above a certain rate, we may find five occurrences in a 20-year record showing an average frequency of occurrence of once in four years, and yet we may find that all of these floods occurred in two years showing that they occur in but 10 per cent of the years.

For designing conduits for flood water, it seems to the writer that the number of cases in which flood damage may occur is of greater significance than the number of years in which there may be such damage, and that the method of analysis by which all of the occurrences above certain values are considered, no matter how many occur within a single year, is of more significance than the one recommended by Mr. Moyer.

CHARLES W. SHERMAN,
Of Metcalf & Eddy, Consulting Engineers.

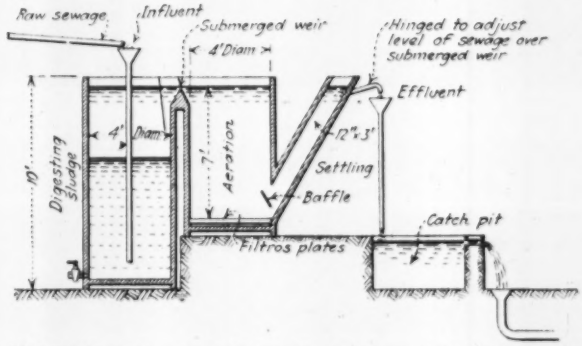
Boston, Mass.,
June 5, 1925.

Disposal of Excess Activated Sludge by Digestion

Sir—I am much interested in the paper by Dr. Karl Imhoff on "Disposal of Excess Activated Sludge by Digestion," read before the American Society of Civil Engineers on May 20 and abstracted in your issue of June 4, p. 936. With Dr. G. G. Nasmith the writer carried out experiments some years ago at the Toronto sewage-works which demonstrated, as Dr. Imhoff now has again demonstrated, that activated sludge could be satisfactorily digested if inoculated with ripe decomposing sludge. This fact was published in the *Canadian Engineer*, Feb. 3, 1921, and fuller details of our experiments are given in the issue of that journal for June 16, 1925. Our experiments extended through several years and were completed in 1920. We had hoped to introduce a plant on a practical scale based upon our discoveries in this field ere this, but the opportunity has not presented itself.

To us the most important discovery we made was that by inoculating the fresh sewage before activation the resulting activated sludge, if allowed to stand, would decompose rapidly without offence, yielding a sludge with the characteristic tarry odor and possessing the good drying qualities of the well-known Imhoff sludge.

As our scheme went much further than sludge digestion it will be best understood by reference to the accompanying sketch. The essential detail was a tank with three compartments through which the sewage passed in series. At the beginning, in the first compartment ripe digested sludge from an Imhoff tank was placed and the sewage to be treated was fed into the bottom of the compartment, passing upward through the sludge into the space above where the mixed sludges from the inoculated sewage settled out and the sewage then passed over a submerged weir into



EXPERIMENTAL APPARATUS FOR DIGESTION OF SLUDGE AND EXCESS ACTIVATED SLUDGE

the second compartment where it went through the process of activation and from thence to the third or settling compartment in the form of a spout. The arrangement was such that the transfer of sludge from the settling compartment to the activation compartment and from the activation compartment to the digestion compartment took place automatically. The amount of sludge maintained in the activation compartment was found to vary inversely with the depth of the liquid over the submerged weir. After a permanent régime had been established the sludge in the digestion compartment consisted of fresh sludge, digested sludge and activated sludge intimately mixed, but we found that no matter where sludge was taken from the apparatus, it would digest in the best way possible even in small quantities contained in a small glass cylinder.

A mechanical difficulty we experienced was the extraordinary rate of gas formation; Fig. 3 of Dr. Imhoff's paper shows the same phenomenon in his experiments where activated sludge, fresh sludge and digested sludge were mixed. From the point of view of obtaining gas for power without long periods of digestion this is a very desirable combination, but in our case we found that, unless the digesting sludges were continually stirred, the level of the liquid in the compartment would rise as much as 3 in., suddenly ejecting large quantities of sludge into the activation compartment which introduced difficulties of settling and occasional throwing of sludge from the settling spout

into a catch pit which was necessary in order that no sludge should be carried away.

The effluent was clear and straw colored, containing an increase of an average of about 70 p.p.m. of dissolved solids, showing that a considerable proportion of the solids dissolved and that very little sludge accumulated during the two years continuous operation of the plant. A typical average chemical result is expressed in parts per million as follows:

	Free Ammonia	Albumenoid Ammonia	Nitrates	Putrescibility
Fresh sewage	10.1	4.1	1.1	30
Outlet of digestion compartment	10.1	5.0	1.3	30
Effluent	1.5	0.7	16.3	100

The air used was 8 cu. ft. per gallon of sewage with a depth of 7 ft. in the activation compartment and the total volume of the apparatus was 12 hours' supply.

We believe the idea of digesting the whole of the sewage, as well as the sludge, carried out in our experiments has distinct possibilities because of the absence of smell, the small amount of sludge collected, the good drying qualities of the sludge and the high purification secured with a relatively small amount of air.

It is clear that the experimental work of Dr. Imhoff in developing a sludge with the novel and valuable properties described has confirmed the results independently discovered by us during the years 1916 to 1920 at Toronto.

WILLIAM GORE,
of Gore, Nasmith & Storrie,
Consulting Engineers.

Toronto, Ont.,
June 16, 1925.

A Plea for Work for Rehabilitated Veterans

Sir—I have read with considerable interest the appeal of the Director of the United States Veterans Bureau to the engineers of America for them to employ ex-service men wherever possible. As a major disabled man myself, with a college degree obtained before enlisting, perhaps the results of some intimate knowledge of the subject may be of interest to the readers of *News-Record*.

In the first place, regardless of how well a man stood in college, regardless of what his technical qualifications are, if he has not had that bugaboo called "experience" the engineering profession shuns him. Furthermore, if a man happens to be so fortunate as to get a contact with an engineering firm without letting them know that he is disabled, the result is that as soon as the firm is apprised of his physical condition, there is a softening of the voice—if the matter is conducted over the telephone by an employment agency, for example—or there is a suspension of the correspondence, rather abruptly, if the matter is being handled by mail.

This is not just my personal experience but as a member of the only organization in the United State composed of major amputations, the U. S. World War Amps, I say that the comrades with whom I come in contact inform me of the same thing. One man says he was with the largest utility in the world before enlisting. However, now that he wears an empty coat sleeve, they will not listen to him and he is engaged in the Veterans Bureau trying to help find a job for the other fellow. But American industry is not alone in the matter by any means. The United States government is acting hypocritically when it appeals to the industries of the nation to help men and then turns them aside from the Civil Service Commission because of the desire to favor political allies. The very man who was mentioned above told me he had to get a Presidential order to get where he is with the Veterans Bureau. The Civil Service of the United States is supposed to help an ex-service man by giving him preference. I say without hesitancy—without fear of any individual or order—that this is the biggest hypocritical sham that was ever ordered. The commission is so prejudiced against the men that they discount their actual ability in order to get less of them in the service of the government instead of giving them any sort of military preference.

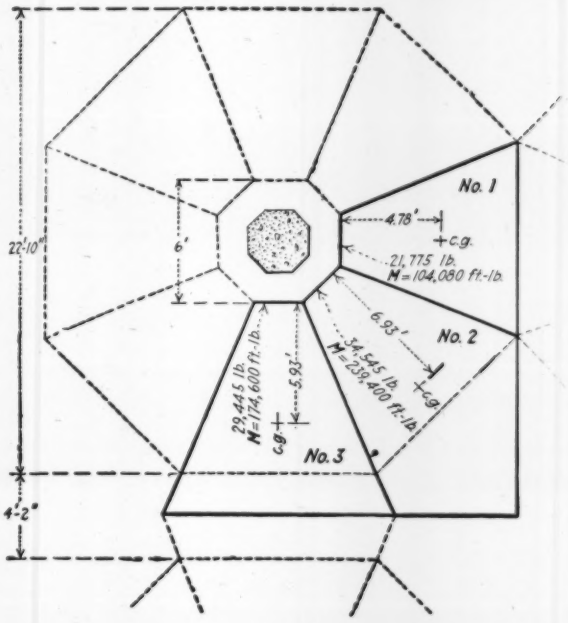
W. BENJAMIN WEST.

New York, N. Y.,
June 20, 1925.

Cantilever Floor Construction Stresses

Sir—The article in *Engineering News-Record*, May 21, 1925, p. 845, entitled Cantilever Floor Construction for Concrete Buildings, presents an interesting problem to the designing engineer as to how far he may go in applying this type of construction.

Analysis of the Printcraft Building design, with 300-lb. live-load provided for, shows that the concrete is sustaining higher unit stresses than those usually recommended. Considering each section of the figure as an independent cantilever bracket the greatest overstress will occur as compression in the bottom of the slab at the edge of the column cap.



STRESSES IN CANTILEVER BRACKETS

The tabulation of stresses below was made for the three typical interior sections as shown by the sketch. As the unit tensile stress used in the design was not given, the result was computed for values between 12,000 and 20,000 lb. per sq.in. The effective depth of the slab at the edge of the column cap was taken as 18 in.

Stress in Steel in Lb. per Sq.In.	Extreme Fiber Stress (Compression) in Concrete in Lb. per Sq.In. 1-2-4 Mix $n = 15$. Section 1	Section 2	Section 3
20,000	792	1,392	1,120
18,000	763	1,355	1,083
16,000	735	1,315	1,648
14,000	705	1,277	1,010
12,000	670	1,230	962

The Joint Committee on Concrete and Reinforced Concrete recommends a value for compression in the extreme fiber in flexure adjacent to supports of continuous beams of 0.45 f'_c or 900 lb. per sq.in. for 2,000-lb. concrete. The elastic limit of such concrete is commonly given at 1,000 to 1,300 lb. per sq.in. and it is of great importance that this value be not exceeded. This would require that the octagonal forms be placed directly adjacent to each other, eliminating the suspended filler slab which is 4 ft. 2 in. wide. Also the filler slab at the corners between forms should be provided with bottom steel to distribute its load to the cantilever sections.

As the unit stress in the steel is increased, the bending moment remaining constant, the neutral axis is brought nearer the compression side of the slab and the unit compressive stress also becomes greater. A relatively low steel working stress is therefore most favorable to this type of design.

N. K. SHEPPARD.

Detroit, Mich.,
June 1, 1925.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Engineering Educators Meet at Schenectady, N. Y.

Research, the Teaching of English to Students and Industrial Engineering Discussed

The thirty-third annual meeting of the Society for the Promotion of Engineering Education was held June 16-20, 1925, at Schenectady, N. Y., with headquarters at the engineering building of Union College. The attendance was large for this society, about 350. It was of unusual interest due to the central-feature, which was the preliminary report of the Board of Investigation and Co-ordination, whose work is being financed by the Carnegie Corporation, a report of whose tentative findings will be published in the issue of July 2.

The formal program occupied two days, June 18 and 19, preceded by two days of well-attended special conferences and inspection trips, and followed by an all-day excursion on Lake George. In addition to the major features the convention was remarkable for the well-conducted special meetings of teachers of English, of electrical engineering and of industrial engineering, each group having programs comprising papers by eminent specialists and discussion of high order. As to English, there was indicated an increasing place for it in technical school curricula, due no doubt in considerable part to the influence of alumni and employers of technical graduates. There is being rapidly developed a class of teachers of English who know what kind of instruction technical students need and who, while not engineers, are striving to get the engineering point of view.

As to industrial engineering, while there is not yet complete agreement as to teaching method, technical schools and industry are appreciating the need for engineering graduates who have a wide outlook upon industry and are better prepared to solve the problems of management.

The fact that this convention was held at the seat of one of the great research laboratories of the country, that of the General Electric Co. was utilized in directing attention to the importance of research in connection with engineering instruction. A notable gathering of eminent research workers was held in the laboratory for discussion of this subject. The consensus of opinion was that there are ample funds available for research but the difficulty is to secure men properly fitted for this work.

As one speaker said: This work requires the soundly trained engineer who can apply to his investigations the results of advanced information. Quality is more important than quantity in engineering. How shall these men be trained? One way is through graduate

(*Continued on p.* 1074)

Engineering Fifty Years Ago

From *Engineering News*, June, 1875

THE BRIDGE to be built over the Monongahela River, at the "Point" at Pittsburgh, will be constructed on the suspension principle, but instead of wire cables, immense chains will be employed, of which there will be two. These chains will be composed of wrought iron links, each twenty feet in length and formed of sixteen flat bars placed side by side, and at a distance from each other of one and two inches. Into these spaces at the ends, fit the bars of the next link, and the entire thirty-two bars are joined by an immense hardened iron pin six inches in diameter and four feet long. The lateral width of the chain is forty inches. At the apex of each iron tower the chain will be attached to an iron "saddle," meeting upon rollers that admit of sufficient play to accommodate the expansion and contraction of the chain from heat and cold. From the top of each tower to the main span, and holding somewhat the same relation to the chain as the string does to the bow, are placed girders, which are intended to prevent sagging of the chains under unusual strain. The plans of the superstructure were prepared by Mr. E. Hemberlee, the American Bridge Company's engineer, which company, as we note elsewhere, has the contract.—*American Manufacturer.*

The contract for the entire work of piers and superstructure of the new "Point" bridge was awarded last Thursday to the American Bridge Company, of Chicago at the price named in their proposal, $401,250. The company let the masonry to John Megraw, of Allegheny. The bridge is to be completed for travel by August, 1876. The entire cost, including approaches, etc., will be about $450,000.

To Construct Another 220,000-Volt Transmission Line

Application was made on May 28 to the California Railroad Commission by the Southern California Edison Co. for permission to construct a 225-mile transmission line designed to bring electrical energy from the chain of power plants on Big Creek at a potential of 220,000 volts to load centers in southern California.

The new line will require a construction period of two to three years, it is estimated, and is to cost about $6,000,000. Its capacity will be 150,000 kw. Bids for material are to be received soon. The conductors specified are aluminum cable with steel cores.

Wide Range of Subjects at N.E.L.A. Meeting

Secretary Hoover Speaks on State Versus Federal Regulation—Special Sections

The annual convention of the National Electric Light Association at San Francisco, June 15 to 19, brought together some 3,000 representative men of the electrical industry from all parts of the country. General sessions were held in the mornings and in the afternoons the several sections, namely, technical, accounting, commercial and public relations, held separate sessions to discuss reports pertaining to their respective fields. At the only evening meeting Herbert Hoover spoke before an audience of about 6,000 people, touching on some of the chief problems of the electrical industry today. In speaking of public relations he said, in part:

"The real issue in this question is whether states, through their regulative powers, are already in control of the situation for the public interest.

"The anxiety in the public mind over these charges is inherited from the bitter chapter of exploitation when the railroads went through a similar era of expansion, consolidation, and interconnection. No one can review that period of wild finance, plunder and corruption in transportation with any feeling of national pride or satisfaction.

Effectiveness of State Regulation

"No one can survey the work of the state commissions and the instructive series of court decisions concerning their rulings as a whole without realizing that we are gradually developing a science of regulation and of understanding on one hand of the means of drawing the fine line between minimum rates to the people and on the other hand of such a reasonable profit to the industry as will stimulate its advancement. It is my belief from an investigation that the Public Service Commissions with very little just criticism are proving themselves fully adequate to control the situation. The laws as written in the state statute books are sufficient to protect both the public and the industry, the two parties to the utility contract.

Federal Regulation

"It has been proposed that as power districts may be no respectors of state lines, we must have federal regulation of power. I do not agree with the conclusion that federal regulation is necessary. I can see no reason for the imposition of a superior regulation, merely because Congress may have the power to exercise its authority under the commerce clause. The essence of regulation lies in a tight grip on the concern that actually deals with the

(*Continued on p.* 1075)

Controversy Over Tolls Delays Delaware River Bridge Work

Final action by the Delaware River Bridge Joint Commission on one of two contracts for work on the Philadelphia-Camden bridge, for which bids were received on June 17, has been held up pending developments in a controversy over whether or not tolls are to be charged. The contract in question provides for the construction of the roadway and footwalk slabs on the two approaches and on the main bridge structure and for the paving of the approach roadways with granite block and of the main structure roadway with asphalt. The slabs are to be of reinforced concrete, the approach slabs being 7 in. thick and the slabs on the suspended spans being 6 in. thick. The bridge is financed jointly by the States of New Jersey and Pennsylvania and the city of Philadelphia. Funds from Pennsylvania have been appropriated from current revenues and funds from Philadelphia have been provided by bond issues of general character which are to be paid for by taxation and retired in 50 years. Pennsylvania and New Jersey desire that the bridge shall be free of toll. New Jersey's share of the costs has been provided, however, by bond issues covering specifically the Philadelphia-Camden bridge and the New Jersey-New York vehicular tunnel. These bonds were voted on and issued with the intention that tolls should pay the interest and retirement charges. The subject of tolls has been a matter of controversy with the members of the Delaware River Bridge Joint Commission for several months. It had been thought that New Jersey would charge toll of vehicles going on the bridge from that side of the river, although no toll would be charged on the Pennsylvania side. In an opinion furnished to the mayor of Philadelphia, however, the city solicitor held that the bridge is an instrument of interstate commerce and that in the absence of an agreement between the two states for levying toll, New Jersey cannot legally make such charges but the entire matter is subject to Federal jurisdiction. In view of this opinion, the New Jersey members of the bridge commission decided to ascertain whether further expenditures of money from the bond issues would be proper if tolls cannot be collected, before further contracts involving New Jersey funds are entered into. For this reason the award of the contract for the roadway and sidewalk slabs was not made on June 19. Counsel to the Delaware River Bridge Joint Commission was directed to confer with the governors of the two states and the attorneys-general and submit opinions on the matter at a special meeting to be held June 29. Further delay in awarding the contract may cause delay in completing the bridge.

Engineering Educators Meet

(*Continued from p.* 1073)

departments in science. Another is by establishing special advanced courses in technical schools. In the past the principal research work in fundamentals has been done by scientists from the graduate departments of universities rather than by engineers. Engineering graduates have been more successful in applicational research.

EDUCATION AND INDUSTRY

One of the best appreciated sessions of the Schenectady meeting was that devoted to the above subject. The speakers were Sam A. Lewisohn, of Adolph Lewisohn & Sons; Ira N. Hollis, retiring president of Worcester Polytechnic Institute; F. C. Pratt, vice-president General Electric Co., and A. I. Lipetz, consulting engineer American Locomotive Co.

Mr. Lewisohn began by stating that large-scale production is the only solution of the economic problem of industry. Hence the engineer must be fitted for positions of administration. The management of human relations must eventually devolve upon the line officials. This being true, and also that technical graduates, while well prepared along engineering lines, are deficient in ability to organize human beings, Mr. Lewisohn advocated training to develop this ability although not with the idea of producing personnel specialists.

President Hollis explained the difficulty of teaching such subjects as human relations in a technical school and charged industry with the responsibility of adapting the product of the schools to the conditions met in practice.

Mr. Lipetz summed the whole subject up by showing how co-operation between teaching and industry can be maintained. After tracing the rather zigzag progress of science and invention, one being ahead now and the other then, he outlined a plan of engineering instruction which looks on an educational institution as an industrial enterprise. The students need to be trained for independent solution of practical problems by solving problems chosen in conformity with actual conditions. Teachers should if possible be actually connected with the industry whose problems they teach.

The president for the coming year will be Dean G. B. Pegram, of Columbia University and the secretary continues to be Dean F. L. Bishop, of the University of Pittsburgh. The meeting next year will be at the State University of Iowa, Iowa City.

Pan-American Road Congress to Be Held in Buenos Aires

The Pan-American Road Congress will be held in Buenos Aires, Argentine, South America, Oct. 3-13. The American delegation will sail from New York, Sept. 3, on the Grace Line Steamer "Santa Anna." The itinerary of the trip includes stops in Panama, Peru and Chili. From Valparaiso, Chili, the delegation will cross the Andes by rail reaching Buenos Aires about two days in advance of the opening of the conference. During the period of the conference visits will be made to other cities in Argentine and probably to Montevideo, Uruguay. Stops have been arranged on the return trip at Sao Paulo and at Rio de Janeiro, Brazil. The party will land in New York on Nov. 11.

John H. Hayward, Pioneer in Construction Equipment, Dies

John H. Hayward, a designer and builder of construction equipment, died at his home in Teaneck, N. J., on June 14. Mr. Hayward was born in New York, April 7, 1847, and after graduating from a military academy took a position in the Manhattan Savings Institution, where he stayed for several years. Later he went into the produce business and was a member of the New York Produce Exchange. About 1873 he moved to Staten Island to live and there met a Dr. Johnson, an inventor, who interested him in the design of machinery and led him to appreciate the advantages to be gained from applying machinery to construction work. Subsequently he became general manager of the Manhattan Dredging & Elevating Co., an organization doing general contracting business. It was while with this company that he assisted in the development, and later manufactured, the so-called orange-peel type of bucket which had been patented by Dr. Johnson some years previous. From this time on Mr. Hayward devoted himself to the design and construction of excavating machinery of various types, later forming the Hayward Co., of which he was vice-president and treasurer at the time of his death. Details of the equipment developed by Mr. Hayward are to be given in a history of the development of construction machinery which *Engineering News-Record* has in preparation.

Plan Fixed Bridges at Chicago

As the latest step in the old project for fixed bridges in place of drawbridges over the Chicago River, a recommendation has been made to the city council by A. A. Sprague, commissioner of public works, to the effect that all existing drawbridges giving a headroom of at least 16½ ft. should be made fixed bridges by Jan. 1, 1930. For reconstructing 42 present highway bridges and building 23 new bridges during the next 50-year period it is estimated that the cost would be about $24,000,000 for fixed bridges, as compared with $60,000,000 if drawbridges are retained. In addition there would be a saving of the enormous aggregate of time now lost while traffic is interrupted by the opening of drawbridges. This change would not affect the Lakes-to-Gulf waterway, as it is designed for barge traffic.

Fellowship in Highway Transport Established at Michigan

A Fellowship in Highway Transport to be devoted to investigations under the direction of the Division of Highway Engineering and Highway Transport of the University of Michigan covering an approved subject relative to the utilization and operation of motor buses has been established recently by the Reo Motor Car Co. of Lansing, Mich. The Reo Motor Car Co. fellow will make investigations relative to the economic fields of motor bus transportation and efficient methods of operation for urban and intercity motor bus systems.

W. J. Dibdin of Contact Bed Fame Dies in England

William Joseph Dibdin, who introduced contact beds for treating sewage in the eighteen nineties, died on June 9 at the age of 74 years. From 1882 to 1897 he was chemist to the Metropolitan Board of Works and its successor, the London County Council. In the late eighties he conducted experiments on the chemical treatment of London sewage which were followed by the construction of the Barking and Crossness precipitation works, put in operation in 1889 and 1892 respectively. In March, 1891, shortly after the appearance of the classic reports on the work of the Lawrence (Mass.) Experiment Station, the London County Council ordered experiments made on the bacterial treatment of sewage—primarily effluent from the precipitation works. These experiments were begun by Dibdin in May, 1892, making use of beds of burnt clay, coke, pan breeze (a harder coke, from near-by gas works) and sand. About the same time, Dibdin induced his fellow members on the Sutton Urban District Council to change the plans for filter beds designed to treat chemical precipitation effluent when it could not be applied to the sewage forms. Of six proposed polarite filters only two were built, with two of coke breeze and two of sand, and an extra bed of "burnt ballast" (clay). In 1895-96 the type of contact beds that for some time bore Dibdin's name were built, and in 1904 triple contact beds were put in use at the Surrey sewage-works.

When the writer of these notes visited Dibdin in 1904, the latter, who was then devoting much attention to slate beds for sewage treatment, expressed regret that he had not taken out patents on the contact beds; he also spoke strongly against the use of septic tanks—which is interesting in view of the subsequent decline of the contact bed and the little footing ever gained by slate beds, correct as their underlying scientific principle may be.

After 1897 Mr. Dibdin was in private practice. He was a past president of the Institute of Sanitary Engineers and of the Association of Managers of Sewage Works. He invented the Board of Trade standard pentane argand, a radial and a hand photometer, read many notable papers, including two on sewage treatment, before the Institution of Civil Engineers (Vol. 88, Part II, 1886-7; Vol. 129, Part II, 1896-7) and several books, one of which was "The Purification of Sewage and Water," published in 1903.

N.E.L.A. Meeting

(*Continued from p.* 1073)

consumer. There is the possibility that generating concerns may sell their power wholesale at the state line to distributing companies, thus attempting to make their wholesale prices exempt from the regulation of the consuming state. But that state still regulates the price and service of the distributing company. Most commissions exercise supervision of the contracts for purchase of power. The commissions are unlikely to blindly accept as an item of cost the amount paid to an external transmission company for its power, but rather they will examine the cost and reject it as a basic element if found unfair or excessive or collusive. The utilities themselves would do well not to oppose it. It would fill the only gap open for federal intervention. For the rest co-operation between commissions could settle the possible minor questions.

"And there are the most weighty of reasons against federal regulation. Power is, by necessity, bound to be local in its districts—as to its service, its generation and distribution. It differs widely from the interstate implications of the railways where they are dependent not upon districts but upon whole groups of states. Local acquaintance, local valuation and public opinion can operate upon power to their fullest extent. Nothing will produce worse service than to attempt to transfer local problems to absentee solution at Washington. And if our democracy will stand at all it must stand upon the local responsibility. Nothing could be a more hideous extension of centralization in the federal government than to thus undermine the state utility commissions and state responsibilities."

Technical Sessions

At meetings of the technical section there were usually five or six hundred present; there was little or no discussion on most of the papers. The report of the Hydraulic Power Committee, typical of the reports summarizing the year's work of the several technical committees, reviewed progress in hydraulic power development and recommended ways and means of co-operation in further study. This year's report contained only a short statement about the pitting of turbine runners because manufacturers objected to the form of the report as originally prepared and publication was postponed in the hope of reconciling statements of manufacturers and committee members for a comprehensive statement next year. Snow surveys were mentioned as an important factor in economical purchase of fuel for standby service and extension of the chain of snow-measurement stations in the Sierra Nevada Mountains was reported.

A paper on "Special Features in Western Turbine and Water-Wheel Design" by E. C. Hutchinson, vice-president Pelton Water Wheel Co., summarized recent improvements in automatic control equipment, hydraulically balanced valves, rubber seal rings, runners and draft tubes. An excellent series of slides was shown with this paper.

H. A. Barre, Southern California Edison Co., read a paper on "Some Factors Affecting the Relation of Steam and Water Power in Combined Systems," Col. William Kelly, formerly of the Federal Power Commission and now director of engineering, N.E.L.A., spoke of his need for co-operation in co-ordinating the work of 500 committees and sub-committees of the organization. William F. Durand, president, American Society of Mechanical Engineers, read a paper on "The Engineer as a Factor in Human Affairs."

Pacific Port Authorities Meet in San Francisco

The twelfth annual convention of the Pacific Coast Association of Port Authorities was held in San Francisco, June 18, 19 and 20. With a registration of about forty delegates, Pacific Coast cities from Vancouver, B. C., to San Diego, Calif., were well represented.

The papers presented included the following: "Dredging," James H. Polhemus, general manager and engineer, Port of Portland, Portland, Ore.; "Purposes and Progress of Port Development at Seattle," George F. Cotterill, president Port Commission, Seattle, Wash.; "Municipal Belt Lines," C. J. Colden, president Board of Harbor Commissioners, Los Angeles, Calif.; "Determining Factors in Selection of Piling for Waterfront Structures," George F. Nicholson, harbor engineer, Los Angeles, Calif.; "Waterfront Zoning," M. A. Graham, president Board of Harbor Commissioners, San Diego, Calif.; "Jacketed Piles," Frank G. White, chief engineer Board of State Harbor Commissioners, San Francisco, Calif.; "Advantages of a Cold Storage Plant as a Port Facility," Col. G. H. Kirkpatrick," president Vancouver Harbor Commission, Vancouver, B. C.; "Port Traffic," W. S. Cahill, traffic manager Port of Seattle, Seattle, Wash.; "Responsibilities of Ports to Shippers and Operators," Fred. S. Knight, chief wharfinger Board of State Harbor Commissioners, San Francisco, Calif.

In the discussions emphasis was given to the need for water-proofing concrete structures between low and high tide levels. The crystallization of salts as moisture evaporates was cited as a frequent cause of progressive deterioration between tide levels in structures that might show no deterioration above or below this zone.

Experiments and tests on suction dredges at Portland to determine the types of cutter heads best suited to handling materials were reported and refrence was made to studies now under way with Wood screw pumps to reduce difficulties with obstructions.

Attention was directed to the importance of port zoning for the purpose of (1) segregating freight involving fire hazard, such as oil and lumber, (2) assigning works likely to produce smoke or smells with respect to prevailing winds and (3) reserving suitable locations for aquatic parks and places of public amusement.

Canadian Harbor Construction

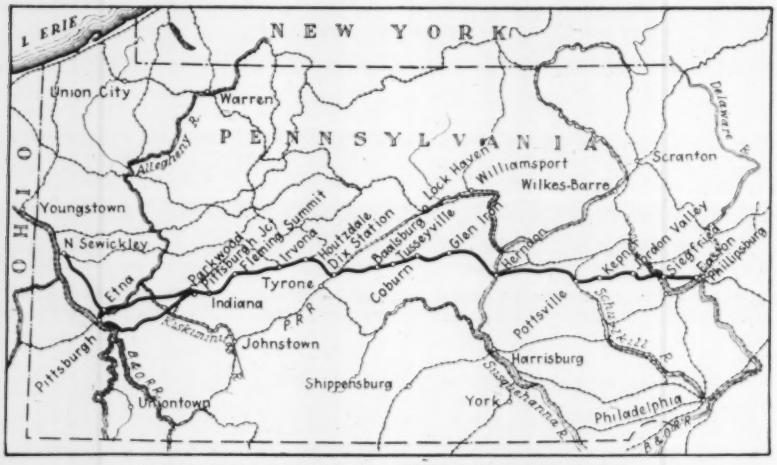
The Canadian Parliament has voted an appropriation of $5,000,000 for extensions to the Quebec harbor. This will enable the harbor commissioners to continue the work they started last fall and which will take several years to complete.

The program for the improvement of the harbor at Toronto, Ont., Canada, calls for an expenditure of $7,500,000 during the next five years. This includes the cost of filling necessary for the new viaduct construction along the water front.

Railroad Across Pennsylvania Discussed Before Commission

Objections were entered and answered before the director of the Bureau of Finance of the Interstate Commerce Commission, at a hearing in Washington June 22 on the application of the New York, Pittsburgh & Chicago R.R. Co. for a "certificate of convenience and necessity" to build a new line of railroad across the state of Pennsylvania as a link in a proposed railroad system reaching from the Atlantic seaboard with the Middle West. A subsequent session will be held at a date to be fixed later when witnesses for the applicant will be cross-examined.

The New York, Pittsburgh & Chicago Railroad Co. early in April applied to the commission for authority to build a railroad from Pittsburgh to Easton, Pa., a distance of 283 miles, with two branch lines, as shown in the accompanying map. Its proposition is a revival of a similar railroad project started about twenty years ago. In 1914 the line was located from Pittsburgh as far as the Susquehanna River and plans were prepared for the bridges, viaducts and tunnels. From the Susquehanna to Easton the line has not been located on the ground.



PROJECTED RAILROAD ACROSS PENNSYLVANIA

The railroad will be double track and will have an 0.3 per cent grade against eastbound traffic and 0.4 against westbound, except for a 7½-mile pusher grade of 1.38 per cent. The maximum curvature is 4 deg. On account of the mountainous character of the country, the grading will be heavy and there will be numerous tunnels and viaducts, some of the latter being considerably over 100 ft. high and one of them being 300 ft. high. The maximum tunnel length is 15,000 ft. All construction is to be of permanent character and all highway and railway crossings separated.

The estimated cost per mile is as follows: Roadway construction, $530,000; equipment, $128,000; and general expenses, which include interest during construction, $99,000, a total of $757,000 a mile.

The projected line forms an essential link in the trunk line railroad system which L. F. Loree, president of the Delaware & Hudson, is reported to be planning. By using the Lehigh Valley from Easton to New York and the Wabash west of Pittsburgh, he will have a line from New York to Chicago 80 miles shorter than the Pennsylvania and still shorter than either that of the Baltimore & Ohio or the New York Central.

At the hearing counsel appeared for the New York Central and the Pennsylvania railroads, which have entered opposition on the ground that existing facilities are adequate to handle traffic in the territory. Daniel Willard, president of the Baltimore & Ohio, testified that the proposed line, if built, simply would take away business from lines with present capacity to handle all traffic in the territory.

L. F. Loree, who represented the E. H. Harriman estate, which is interested in the proposed road, testified that Mr. Harriman many years ago became interested in the proposal and acquired franchises and rights under which it is now proposed to proceed. He declared the attitude of the New York Central inconsistent in that two years ago its officers testified that there is need for additional lines through Pennsylvania. If the application is granted, those behind the project can finance it easily, Mr. Loree said.

F. A. Molitor, president of the applicant corporation, said he had surveyed the proposed line in 1913 and that in 1914 part of the route was staked. Replying to criticisms that the cost of construction would be excessive, Colonel Molitor explained that the estimate of $757,000 a mile included interest during construction and equipment. Referring to construction costs in past years, Colonel Molitor pointed out that one railroad constructed in 1914 cost $333,000 a mile while, due to recognized increases in cost since that year, it would cost twice that sum per mile today.

Plans for Toronto, Ont., Viaduct

The plans and specifications for the railroad viaduct to be built by the Canadian Pacific and the Canadian National Rys. are practically completed and it is expected that bids will be called for in the near future.

Engineers Appointed to Draw Up Plans for $5,000,000 Dam

A board of consulting engineers to supervise plans and specifications for the construction of the Coolidge Dam on the San Carlos Indian Reservation in Arizona, was named June 22 by the Commissioner of Indian Affairs with the approval of the Secretary of the Interior.

The members of the board include, Louis C. Hill, construction engineer, and Fred A. Noetzli, designing engineer, Los Angeles, Calif., and Andrew J. Wiley, construction engineer, Boise, Idaho. All of the appointees have wide experience in engineering and irrigation enterprises in the West, two of them having served with the Bureau of Reclamation.

The dam, which will be built across the Gila River near San Carlos, will cost approximately $5,000,000 and will store water for the irrigation of from 75,000 to 100,000 acres of Indian lands, public and private lands in the lower Gila River Valley. It will furnish a permanent supply of water to the Pima Indians living on the San Carlos Reservation.

Congress recently authorized the construction of this reclamation project, the expenditure not to exceed $5,500,000. An appropriation of $450,000 has been made to begin work and the selection of a board of consulting engineers to draw up and supervise plans and specifications for the dam will be the first step toward completion of the project.

Construction Starts on Rocky Creek Power Plant

Construction has been started on the twelfth hydro-electric plant of the Southern Power Co.'s system. The new plant is at Rocky Creek on the Catawba River in South Carolina. The plant will have an installed capacity of 60,000 hp.

Village Sewage Works Projects on Long Island, New York

Sewage-treatment projects for several villages on the Long Island coast as an outcome of last winter's oyster-typhoid outbreak are reported by *Health News*, the official organ of the New York State Department of Health. Conferences between local officials and the sanitary engineers of the department have been held. The status of the various projects is summarized by *Health News* as follows: "At Patchogue a committee is taking the initial steps toward establishment of a sewer district to include a part of the village and it is expected that a disposal plant ultimately will be constructed. At Greenport plans have been prepared and sent to the state engineer for approval. At Riverhead a committee has been appointed to study the local disposal problem and make recommendations. The village board of Sag Harbor, after holding a public meeting at which sentiment appeared to favor immediate action, has directed its engineer to prepare estimates. A settling tank has already been constructed at Shelter Island."

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, Atlantic City, N. J., June 22-26, 1925.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Summer Meeting, Salt Lake City, July 8-10, 1925.

AMERICAN PUBLIC HEALTH ASSOCIATION, New York City; Annual Convention, St. Louis, Mo., Oct. 19-22, 1925.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Petersburg, Fla.; Annual Meeting, Des Moines, Iowa, Oct. 26-29, 1925.

The Engineers Society of Pennsylvania has elected the following officers for the ensuing year: Frank A. Slack, Harrisburg, Pa., president; Thomas M. Kelker, Harrisburg, Pa., and R. Boone Abbott, Reading, Pa., vice-presidents. Theodore J. Gould is secretary of the society.

The Association of Consulting Engineers of Canada has been granted a dominion charter of incorporation. The purposes of the association are to promote ethical standards and practical efficiency in all branches of consulting engineering and to increase the usefulness of the profession to the public. The incorporators are de Gaspe Beaubien, Robert A. Ross, Arthur Surveyer, James L. Busfield, Henry Holgate, and others of Montreal. The head office of the organization will be at Montreal, Quebec.

Personal Notes

J. FLOYD HALL has been appointed borough engineer, Borough of Swissvale, Pittsburgh, Pa., to succeed his father, the late J. D. HALL.

ROBERT H. WHITTEN, Cleveland, Ohio, city planning and zoning consultant, who was secretary of the city plan and zoning commission, New York City, from 1914 to 1917 and consulting engineer to the city plan commission of Cleveland from 1918 to 1921, announces the removal of his office from Cleveland to 175 Fifth Ave., New York City.

ROBERT RIDGWAY, president of the American Society of Civil Engineers, and chief engineer of the New York State Transit Commission, was given the degree of master of arts at the commencement of Harvard University. Later he addressed the alumni, discussing to some extent the apathy of many of the eligible voters of the country and the tendency of the other half to criticize the government but also noting that there is a steady improvement in the standards of administration of public affairs.

A. M. RAWN has been appointed assistant to the chief engineer of the Los Angeles County sanitation districts. Mr. Rawn has been connected with this work since the inception of the plan to consolidate into one office the sanitation work of the entire county.

SYLVESTER Q. CANNON, city engineer of Salt Lake City, Utah, since 1913 and water supply engineer of the city for a year previous to that time will resign in the near future to devote himself exclusively to his duties as one of the heads of the Mormon church.

L. P. M. GAYLORD has been reappointed county superintendent of Highways for Lewis County, New York, with headquarters at Lowville, N. Y.

O. C. MERRILL, executive secretary of the Federal Power Commission, received from Bates College this week the degree of Doctor of Science; Mr. Merrill was a graduate of the school in 1899.

E. W. ODBERT, Sturgeon Bay, Wis., has been appointed city engineer of that city.

LOUIS D. RICKETTS, consulting engineer, New York City, well known as a mining engineer in Arizona and at one time state geologist of Wyoming, received the degree of doctor of engineering June 17 from Princeton University, from which he graduated in 1881.

GUY A. REMINGTON, general manager of the Nampa-Meridian Irrigation District, has tendered his resignation, effective July 1, in order that he may become manager of the Wichita County Water Improvement District at Wichita Falls, Tex., to which position he was elected recently. Mr. Remington has been in the employ of the Nampa-Meridian Irrigation District for 11 years and has been general manager for the past 4 years.

S. R. GRAY, has been appointed city engineer of Chippewa Falls, Wisconsin.

W. W. FINEREN, Jacksonville, Fla., assistant engineer in the office of the United States district engineer, has resigned that post after 23 years in the service of the government, to engage in business in other fields. Mr. Fineren graduated from Cornell University in 1902 and since that time has been continuously with the United States Engineer Department, on work in New York, North Carolina, New Jersey and Florida; in Florida he had been engaged in construction work at Tampa, Key West and Jacksonville.

ROSWELL E. PFOHL and THOMAS S. MCLAUGHLIN announce the establishment of the firm of Pfohl & McLaughlin, Inc., architects and engineers, 830 Walbridge Building, Buffalo, N. Y. Mr. Pfohl is a graduate of the Massachusetts Institute of Technology and was formerly chief engineer for Moran, Maurice & Proctor, consulting engineers, New York City. Mr. McLaughlin pursued a special course of study in architecture at the Massachusetts Institute of Technology and has for the past nine years practiced architecture at Providence, R. I.

Obituary

BRIG. GEN. CHARLES E. L. B. DAVIS, whose death was noticed in last week's issue, graduated from the U. S. Military Academy in 1866 instead of 1886 as stated there. His appointment to the rank of brigadier general was made in 1908.

GEORGE S. ROBINSON, a civil engineer who was associated with the Potomac Electric Power Co. for a number of years, died at his home in Washington, D. C., June 12.

WORTHINGTON M. JACOBUS, formerly a member of the New Jersey Ship Canal Commission and later its consulting engineer, died at his home in Passaic, N. J., on June 16, aged 58 years.

CHARLES R. WHEELOCK, civil engineer, Orangeville, Ontario, died June 5 after an illness of several weeks, aged 59 years. Mr. Wheelock was senior member of the engineering firm of Wheelock & Christie, and had been county engineer of Dufferin and Peel; he was also a past president of the Ontario Good Roads Association.

HERMAN G. GREEN, contractor, Green Bay, Wis., was accidentally killed while superintending the construction of a state highway bridge over the Brazos River near Valley Junction, Tex., on April 22, 1925. He was born in Green Bay, Wis., March 17, 1876, and received his education at Cornell University, afterwards associating himself with his father, Adolph Green, bridge contractor for many years. In 1917 the company was incorporated under the title of Adolph Green Construction Co., of which the son was vice-president. In 1920, upon the death of Adolph Green, he became president which position he held up to the time of his death. Among the most recent larger projects completed under his supervision was the Main St. bridge over Fox River at Green Bay, Wis.

PROF. H. MULLER-BRESLAU, of Berlin Technical College, Berlin, Germany, died April 23, at the age of 74. He had held the chair of mechanics of construction and steel bridges at this institution for 35 years, having succeeded the well-known Winkler, and was a leader in the development of structural theory during his entire career. His principal book, "Statik der Baukonstruktionen," has long been a standard for structural design in Europe.

J. D. HALL, borough engineer, Borough of Swissvale, Pittsburgh, Pa., died May 27, age 63 years. Mr. Hall had been in active practice of civil engineering for the past 37 years, had been borough engineer of Swissvale for 8 years and previously had been borough engineer of New Kensington, Arnold and Parnassus.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

Concrete Road Yardage

For May the square yardages included in concrete pavement contract awards, according to reports to the Portland Cement Association, were: 7,724,075 for roads; 4,169,707 for streets; and 392,656 for alleys; or a total for the month of 12,286,438 sq.yd.

The accompanying table summarizes the statistics for the current year.

SQUARE YARDS OF CONCRETE PAVEMENT AWARDED DURING 1925

Month	Roads	Streets	Alleys	Total All Classes
Jan.....	3,474,421	963,256	75,236	4,512,913
Feb.....	3,787,192	1,201,224	58,723	5,047,139
Mar.....	5,728,862	2,483,662	190,553	8,403,077
Apr.....	12,462,646	4,431,220	469,117	17,362,983
May.....	7,724,075	4,169,707	392,656	12,286,438
Total	33,177,196	13,249,069	1,186,285	47,612,550

Western Road Show Is Planned

The Western Road Show to be held in San Francisco Nov. 9-14, will include not only exhibits of construction equipment but also demonstratons of the machinery in actual operation. This combination is made possible by the 18 acre show site that is provided.

The show is sponsored by the Western Construction Equipment Distributors, an organization containing 90 per cent of the construction machinery dealers of the West. No attempt has yet been made to sell space for exhibits, but the secretary, P. H. Curtis, of *Western Highways Builder*, reports that enough firms have already indicated their intention to exhibit to insure the financial success of the show.

There will be several conventions held in conjunction with the road show, and different days have been set apart and programs arranged for the contractors, engineers, supervisors and dealers.

Ford Makes 500,000 Tractors

Ford Motor Co., reached the half-million mark in the production of Fordson tractors, May 21, when Fordson No. 500,000 came off the assembly line at the River Rouge plant.

Manufacture of Fordson tractors today presents a striking contrast to the methods employed eight years ago when production began at the old plant at Dearborn. At the start only three or four Fordsons were produced each day and it took weeks to machine some parts. Today at the River Rouge plant, where all tractors are now manufactured and assembled, output is on a schedule calling for 400 Fordsons a day. The production schedule shows that 31 hours and 8 minutes after iron ore has arrived at the River Rouge docks it is converted and assembled into completed tractors.

The Fordsons almost immediately became a factor in the war, for England, lacking enough horses to plow ground necessary for food, turned to mechanical power and the first 5,000 Fordsons manufactured were purchased by the Ministry of Munitions for farm work in the United Kingdom. Because of this it was not until 1918 that the Fordson tractors began to reach the American farmer and the construction field. Economies effected on the farms by use of the Fordson have in late years attracted other users of power. The result has been that the Fordson has invaded one field after another until at the present time more than twenty per cent of those sold are for use in industrial lines where power is a factor.

Business Notes

WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburgh, reports, in its financial statement for the fiscal year ended March 31, 1925, sales of $157,880,291. Factory cost, including depreciation and taxes, amounted to $144,242,065, leaving a net manufacturing profit of $13,638,226. The decrease in the total value of all orders booked was 5 per cent as compared with the previous year. The value of unfilled orders at the close of the fiscal year was $55,271,908, compared with $63,738,702 at the close of the previous fiscal year.

L. R. MEISENHELTER, specialist in arranging industrial exhibits, has been placed in charge of assembling the various transportation, mining and manufacturing exhibits for the Sesquicentennial International Exposition in Philadelphia in 1926. He was formerly chief engineer with the Harrisburg Engineering Co. and prior to that vice-president in charge of mechanical engineering for the Houston Standwood & Gamble Co.

BLAW-KNOX CO., Pittsburgh, had as its guests, May 27, forty-three of the leading subway engineers of New York and Philadelphia. After going through the Blaw-Knox factory, the engineers were taken out to inspect the Blaw-Knox inundation system and other equipment and methods that are being used in the construction of the new University of Pittsburgh stadium.

CHICAGO BRIDGE & IRON WORKS, through its New York office, has received an order from the Vacuum Oil Co., for 57 tanks of varying capacities for Melbourne, Sydney, Adelaide and Brisbane in Australia and Wellington and Auckland in New Zealand. Wiggins floating roofs will be used on 28 of the tanks. Approximately 2,500 tons of steel are involved.

CHARLES F. ABBOTT, executive director of the American Institute of Steel Construction, has been appointed a member of the committee on trade relations in connection with the National Distribution Conference as organized by the Chamber of Commerce of the U. S., for the purpose of studying problems of distribution. Mr. Abbott has had much experience along the line of work that is outlined for the committee, having been sales executive and organizer of the New York Sales Manager's Club, the American Society of Sales Executives, and chairman of the Marketing and Distribution Council of the Advertising Club of New York.

WHITE CO., Cleveland, Ohio, announces that H. D. Church has been appointed director of engineering. He was formerly chief engineer of the truck department of the Packard Motor Car Co. and assistant chief engineer of the Chevrolet Motor Co. George W. Smith, formerly in charge of the experimental and research departments, has returned to the White Co. as technical assistant to the vice-president and general manager.

E. M. MCLEAN, formerly division sales manager of the Four-Wheel Drive Auto Co., Clintonville, Wis., has been promoted to the position of general sales manager. Mr. McLean went with the FWD Co. in 1916 as advertising manager. Prior to that time, he had been associated with the Armleder Truck Co., Cincinnati, Ohio, and with the Western Electric Co.

E. R. SUTER has been appointed representative of the building equipment department of the Duriron Co. with offices at 110 South Dearborn St. Chicago. Mr. Suter's territory will cover northern Indiana, northern Illinois, Wisconsin, and the upper peninsula of Michigan.

Equipment and Materials

Standardization of General Purpose Motors

General Electric Co., Schenectady, N. Y., has recently added a new d.c. motor and a redesigned a.c. motor to its general purpose line, which now includes all standard speeds and horsepower ratings for use on any standard circuit. An outstanding advantage of the standardization of these motors is the fact that the bearing linings are interchangeable between the alternating and direct current types; they are also, for the most part, interchangeable in any given type of motor, a total of 2,500 ratings listed utilizing not more than 23 different bearings.

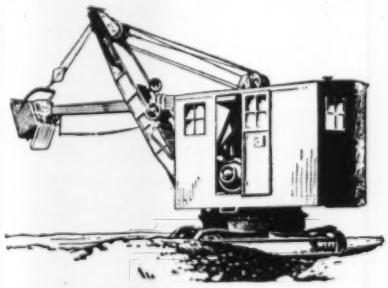
The redesigned a.c. motors supersede the KT-300 line, and are of the squirrel cage and wound rotor type. Standard power ratings range from 5 to 200 hp. This line of motors includes both horizontal and vertical machines. The horizontal motors are suitable for belt, gear or chain drive or direct connection, and the vertical machines are mainly adapted for direct connection.

The new d.c. motors include both constant and adjustable speed machines. The outstanding improvements on the d.c. motors are mechanical including riveted frame construction and steel-shell babbitted bearing linings. The

General Electric Co. advocates the use of sleeve bearings on its motors, but will furnish ball bearings to those who prefer this type.

One-Half Yard Gas Shovel-Crane Uses Only 18 Gears

For the use of road contractors who have need for cranes and shovels at different times but do not wish to buy separate pieces of equipment for which they do not have use at the same time, the Brown Hoisting Machinery Co., Cleveland, Ohio, has recently put on the market a new ½-yd. capacity gas engine crawler shovel-crane.



Features of this machine are its extreme simplicity (there being only 18 gears), its pivot steering device, and its quick convertibility to dipper shovel or clam-shell work. Pivot steering, accomplished by having the creepers run in opposite directions, makes possible the working of this shovel in narrow quarters. Steering is controlled entirely from the operator's position and without swinging the boom. The crowding motion, which is of the rope type, is controlled by one lever, and is entirely independent of the dipper hoist. This feature permits the dippers to be crowded in or out while digging.

Small Motion Picture Camera

The Bell & Howell Co., Chicago, has designed and built a motion picture camera for commercial use. This camera weighs 4½ lb., may be held in the hand or used with a tripod and operates at two speeds—normal (sixteen pictures per second) or half normal (eight pictures per second). It has a universal focus lens which eliminates the necessity of adjusting the camera for distance. The camera is daylight loading, and the films, which come in 100-ft. rolls have a capacity for 4,000 views per roll. A key-winding spring motor controlled by a governor operates the camera.

The company also markets a projector which connects to any 110-volt light socket and folds up to fit into a small carrying case. The projector weighs 9½ lb.—packed into the carrying case; with film, it weighs 14½ lb.

It is suggested that the motion picture camera and projector will be useful to contractors, engineers and salesmen who wish to demonstrate equipment performance. Its use as an aid to the engineer in consulting work, particularly, is obvious.

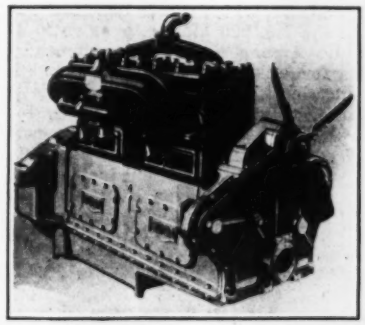
Batch-Measuring Bins for Road-Building Uses

A new type of bin for use in road building has been brought out recently by the Erie Steel Construction Co., Erie, Pa. This bin, which is called the improved Type C plant, has four sloping sides to reduce the amount of dead storage to a minimum. It is used in connection with the company's Type C telescope AggreMeter boxes. The bins are made in two sizes, of 85 and 115 tons capacity.

The AggreMeter boxes are of the telescope type, the sand having adjustment of 6 to 13½ cu.ft. and the stone 12 to 24 cu.ft. Any size batch between these limits can be had. The operating boxes are of the cutoff type mounted on rollers, and to fill the boxes the operator opens both gates with the same operating lever and the material flows until the boxes are filled.

New Heavy-Duty Engine

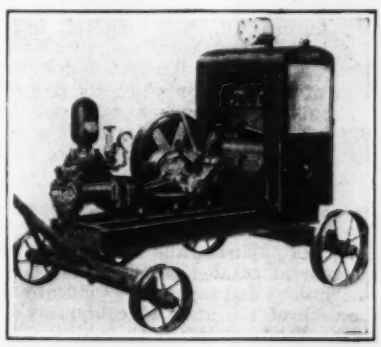
The Buda Co., Harvey, Ill., recently put on the market a heavy-duty engine which develops approximately 50 b.hp. at 600 r.p.m. and 83 b.hp. at 1,000 r.p.m. The engine is built with the idea of taking full power from either end of the crankshaft. The cylinder blocks are cast in pairs to facilitate handling. All working parts of the engine are reached by forced lubrication from a geared pump. The crank case is drained by turning a lever on the side of the crank case without the usual necessity of getting underneath. As shown in the illustration, the crankcase is equipped wtih large hand holes on the carburetor side for inspection or adjustment purposes. The exhaust manifold has a vertical center outlet and makes a very convenient connection for industrial purposes, as the exhaust may be carried off vertically from the center.



This engine finds application in operating such equipment as cranes, hoists, air compressors, shovels, and pumps. It may be furnished either in the bare condition as shown in the illustration or as a complete power unit with sheet metal and steel base.

Improvements Made in Road-Building Pump

The Novo Engine Co., Lansing, Mich., announces changes in its Type W pump. The new design has special adaptability to road-building such as water-supply for the paving mixer, roller and for wetting subgrade and curing concrete. The development of larger power units for this pump some years ago increased its usefulness and capacity, and considerable paving work was made possible with infrequent moving of the pump. At first the cooling water for the power unit was piped directly from the pump to the engine, eliminating the radiator, fan and accessories. Recently it was deemed advisable to use the standard No. 50 power unit, complete with steel housing, radiator and fan, so that the engine could be used as a power unit, operating independently of the pump. The outfit, thus built, may be left unattended for long periods.



Rivet Forge Has One-Piece Hearth

The Buffalo Forge Co., Buffalo, N. Y., has designed a rivet forge with a hearth made entirely from one piece of heavy steel plate. This forge is lighter but stronger than the old two-

piece construction and has no seams to collect moisture and rust. The features of this forge are its deep drawn, 18-in. pressed steel fire pan with turned down brim, which serves as a tool rest, and the No. 200 blower, gear ratio 47¼ to 1. Among the other equipment of this forge is a cast-iron gear case with inspection cover, improved blower clamp, volute type of fan case, four steel pipe legs supported by properly placed leg clamps, correctly perforated tuyere plate, steel windshield and a fan shaft that runs on New Departure ball bearings. Ease of knocking down

and setting up is due to the handy way in which it is fitted for this purpose. The four legs are held together half way down and at the top with clamps. This forge weighs 95 lb., measures 43 in. to the top of the hearth, and its largest leg spread is 35 in.

Publications from the Construction Industry

Road Construction — BARBER-GREENE Co., Aurora, Ill., has compiled, in a 48-p. booklet, entitled "Results on Road Jobs," a series of illustrated descriptions of the uses to which its line of road-building equipment was put in 1924. The booklet devotes itself especially to portable belt conveyors and bucket loaders.

Road-Building Equipment — AUSTIN-WESTERN ROAD MACHINERY CO., Chicago, has published the 1925 edition of its general catalog which gives short descriptions and technical specifications for each of the units of equipment in Austin-Western line. In addition to the material contained in the 1924 catalog, this 95-p. booklet describes the new equipment, including leaning-wheel graders, motor graders, portable conveyors, and for-cylinder motor rollers.

Road Rollers—HUBER MFG. CO., Marion, Ohio, describes its new gasoline motor roller which is a result of a half century's experience in manufacturing self-propelled tractive units. Besides the descriptive matter, the booklet is replete with illustrations not only of the roller and attachments, but also of many of the details; a colored cross-sectional view of the power unit shows the lubricating system.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

U. S. World Trade Position Strong

"The export trade of the United States for 1924 amounted to $4,591,000,000, an increase of $423,000,000, or 10.2 per cent, over the total for 1923," reports the Foreign Commerce Department of the Chamber of Commerce of the United States.

The 1924 imports, amounting to $3,611,000,000, show a decline of $182,000,000, or 4.8 per cent, from the 1923 level.

Export gains were principally in wheat and other grains, raw cotton, copper, and other non-ferrous metals, machinery, vehicles, petroleum, tobacco and rubber. Declines were noted in coal-tar products, paints, pigments, fertilizers, meats, wood and paper.

Import gains occurred in foodstuffs and the non-metallic mineral products. Losses were recorded in animal products, textiles, gums, resins, rubber, tobacco, metals, chemicals and wood-paper.

Commenting upon these favorable developments in our world trade, Chauncey D. Snow, manager of the Foreign Commerce Department, states that "continued increase in exports, and a decrease in imports mark the year 1924. The monthly average for exports figured nearly $383,000,000, and the monthly average for imports, nearly $301,000,000. Automobiles continued their upward course and would have ranked second in the value list, though still at some distance from King Cotton, if wheat had not again emerged from the ranks and claimed second position. Coal had to give way to the gasoline and naphtha group."

That this favorable trade position has been maintained is shown by latest reports. May exports from the United States were $370,000,000, against $335,098,701 during the corresponding period in 1924. Imports totaled $328,000,000, compared with $302,987,791 for the same month last year.

This Week's Contracts—Week Ago—Same Week Last Year

The money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks.

Minimum costs observed are: $15,000 for waterworks and excavations, $25,000 for other public works, $40,000 for industrial and $150,000 for commercial buildings.

MONEY VALUE OF CONTRACTS LET—ENTIRE U. S.

Week Ending	Public Work	Private Work	Total Contracts
Jun25, 1925	**$24,231,000**	**$31,371,000**	**$55,602,000**
June18,1925	26,919,000	24,635,000	51,554,000
June26,1924	23,038,000	14,521,000	37,559,000
Heaviest Week			
1924, May 8	26,370,000	38,829,000	65,199,000
1925, Apr. 2	43,603,000	27,633,000	71,236,000
Jan. 1 to Date			
1925..	500,344,000	644,154,000	1,144,498,000
1924..	487,201,000	539,829,000	1,027,030,000

SOME OF THE CHIEF EXPORTS AND IMPORTS DIRECTLY OR REMOTELY RELATED TO CONSTRUCTION

Exports

Commodity	Value 1924	Value 1923	Per Cent Gain (+) or Loss (—)
Automobiles and parts	$205,682,000	$165,270,000	+24.5
Refined copper ingots, bars, etc.	138,298,000	110,489,000	+25.2
Coal and coke	115,961,000	166,014,000	—30.1
Lubricating oil	86,701,000	76,656,000	+13.1
Boards, planks and scantlings	78,631,000	81,057,000	— 3.0
Iron and steel plates, sheets, skelp and strips	58,482,000	58,613,000	— 0.2
Gas and fuel oil	49,262,000	35,708,000	+38.0
Iron and steel tubular products, pipe fittings, etc.	28,302,000	27,322,000	+ 3.6
Logs; round, hewn and sawed timbers	27,500,000	26,584,000	+ 3.4
Tools	15,822,000	15,710,000	+ 0.7
Metal-working machine tools	14,594,000	13,105,000	+11.4
Paints, pigments and varnishes	14,326,000	16,552,000	—13.4
Structural iron and steel	13,387,000	13,993,000	— 4.3
Railway cars and parts	13,117,000	15,627,000	—16.1
Construction and conveying machinery	10,658,000	9,122,000	+16.8
Mining and quarrying machinery	10,080,000	10,137,000	— 0.6
Iron and steel bars and rods	9,367,000	14,752,000	—36.5
Glass and glass products	8,716,000	10,964,000	—20.5
Steel rails	7,954,000	10,274,000	—22.6
Pumps	7,119,000	7,462,000	— 4.6
Steam locomotives	5,649,000	4,422,000	+27.8
Asphalt and bitumen, manufactured	1,214,000	951,000	+27.2
Cement, hydraulic	2,615,000	2,944,000	—11.1
Iron and steel bolts, nuts, etc.	2,933,000	3,823,000	—23.

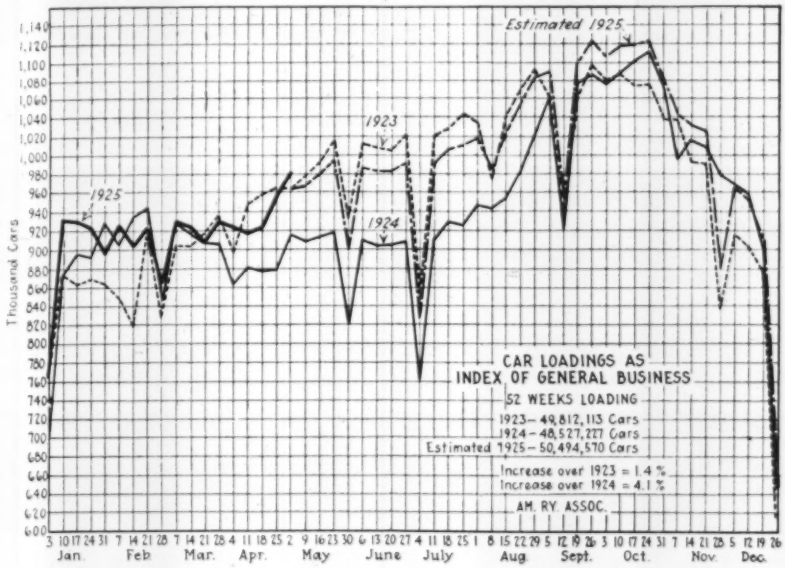
Imports

Commodity	Value 1924	Value 1923	Per Cent Gain (+) or Loss (—)
Boards, planks, deals, and sawed cabinet woods	$52,985,000	$62,480,000	—15.2
Glass	19,171,000	24,898,000	—23.0
Iron ore	10,581,000	11,309,000	— 6.4
Laths	10,152,000	9,332,000	+ 8.8
Shingles	9,328,000	9,812,000	— 4.9
Asphalt and bitumen, un-manufactured	1,203,000	1,080,000	+11.0
Cement, hydraulic	3,117,000	2,964,000	+ 5.0
Coal and coke	3,814,000	13,111,000	—70.9
Pig iron	3,741,000	9,005,000	—58.5
Rails	1,313,000	963,000	+36.0
Scrap	1,026,000	2,783,000	—63.4
Steel ingots	3,074,000	2,372,000	+29.5
Structural shapes	1,904,000	682,000	+178.0
Tubular products	2,782,000	861,000	+224.0
Marble, breccia and onyx	1,283,000	1,507,000	—14.5

Car Loadings Portend Gain in General Business

American Railway Association Expects Increase This Year of 4 Per Cent Over Last and 1 Per Cent Over 1923

An unmistakably optimistic business outlook for the remainder of the current year is gained from the report of the Car Service Division of the American Railway Association.



In his report, M. J. Gormley, chairman, points out logical reasons for expecting heavier freight loadings at the peak of this season, than during corresponding periods since 1923.

It is evident that the volume of 1925 freight traffic will be a trifle over one per cent heavier than 1923 and about 4 per cent ahead of last year.

In estimating loadings for the first quarter of 1925, those submitted by the Division were only 0.7 per cent in excess of actual loadings.

Mr. Gormley's report, in part, follows:

"This estimate of the loading for the balance of the year 1925 is based on our best judgment, supplemented by reports from commodity committees of the Regional Advisory Boards, furnishing estimates of anticipated loading.

"Estimated June and July loading this year is shown to be less than same months of 1923 on the theory that assurance of continued adequate transportation results in not laying in of large stocks in advance of the actual necessities as was done in 1923. This tendency to carry smaller stocks, will, in our opinion, likewise cause heavier loading in the fall months this year to meet demand of that period and cause the high peaks indicated for September and October, which could be obviated to some extent by earlier shipments in anticipation of the fall needs.

"While it may be that we are overly optimistic in our estimate as to the volume of traffic that will be handled during 1925, nevertheless, we cannot find any substantial grounds in support of the statements we hear occasionally about a decline in business and which would justify us in making any change in our estimate.

"Total carloadings, 1925 to date, show

(*Continued on p.* 1082)

Business Briefs

Call money ranged from 3¾ to 4½ per cent, June 22; year ago, 2 per cent.

Time loans, all periods, 3¾@4 per cent.

Commercial paper: best names, 4 per cent; other names, 4¼ per cent.

Foreign exchange (Demand):

	Par	This Week	Last Week	Year Ago
Sterling	$4.86⅔	$4.85⅞	$4.85⅛	$4.32⅞
Franc	.193	.0466	.0480⅛	.0534⅛
Lira	.193	.0375⅛	.0387	.0432⅛
Mark	.238	.2380⅛	.238	
Florin	.402	.4009⅛	.4016	.3748
Peseta	.193	.1455	.1458	.1342
Krona	.268	.2674	.2675	.2654

Use of Average Bids in Handling Minor Items on Estimates

Supplementary to tabulations of average bid prices covering minor items on subway estimate sheets, published in the Feb. 26 issue of *Engineering News-Record*, p. 377, and in the March 26 issue, p. 543, the following list has been prepared.

The items vary little from a standard price and the average is derived from the three lowest bids occurring in estimates on a given number of sections of New York subway and tunnel construction.

The use of the average bid will guide, if not eliminate, the guesswork usually involved in minor items on estimate sheets.

The tables were compiled by Alexander Lyle, Assoc. Mem. Am. Soc. C. E.

AVERAGE BID PRICES COVERING MINOR ITEMS ON ESTIMATES

Classification	Unit	No. of Sects.	Bid Price Maximum	Bid Price Minimum	Bid Price Average	Per Cent Ratio, Max. to Min.
By-pass pipe W.S.—20 in.-above street	Lin.ft.	4	$28.00	$7.00	$16.79	400
By-pass trestle support	Lin.ft.	2	25.00	2.40	8.60	1,040
By-pass cable support—over 16 in.	Lin.ft.	3	25.00	3.60	11.84	695
By-pass cable support—16 in. or under	Lin.ft.	3	25.00	3.60	11.38	695
Service connections for gas pipe	Each	5	100.00	20.00	41.07	500
New C. I. H. and S. pipe—straight	Ton	9	180.00	50.00	99.82	360
New C. I. H. and S. pipe—specials	Ton	8	250.00	82.50	161.54	303
Changing H. P. F. S. pipe— 8 in.	Lin.ft.	2	11.00	2.00	5.33	550
Changing H. P. F. S. pipe—12 in.	Lin.ft.	2	14.00	3.00	6.42	467
Changing H. P. F. S. pipe—16 in.	Lin.ft.	2	15.50	4.00	7.25	388
Changing H. P. F. S. pipe—20 in.	Lin.ft.	1	24.00	5.00	13.00	480
Changing H. P. F. S. pipe—24 in.	Lin.ft.	1	10.00	6.00	8.00	167
New H. P. F. S. C. I. pipe—straight	Ton	2	150.00	80.00	138.33	188
New H. P. F. S. C. I. pipe—specials	Ton	2	300.00	160.00	241.67	188
Changing steam pipe— 6 in.	Lin.ft.	1	60.00	4.00	24.33	1,500
Changing steam pipe— 8-in.	Lin.ft.	1	70.00	6.00	28.67	1,165
Changing steam pipe—15 in.	Lin.ft.	1	80.00	10.00	36.00	800
Changing steam pipe—16 in.	Lin.ft.	1	90.00	10.00	39.67	900
Service connections for steam pipe	Each	1	425.00	150.00	258.33	283
New steel flg. welded steam pipe— 6 in.	Lin.ft.	1	12.00	4.00	6.75	300
New steel flg. welded steam pipe— 8 in.	Lin.ft.	1	15.00	5.00	8.67	300
New steel flg. welded steam pipe—15 in.	Lin.ft.	1	21.00	10.00	15.00	210
New steel flg. welded steam pipe—16 in.	Lin.ft.	1	23.00	12.00	16.83	192
Changing air pipe—6 in.	Lin.ft.	1	10.00	1.50	5.17	667
New air pipe—6 in.	Lin.ft.	1	6.00	1.75	3.25	342
Changing pneumatic mail tube—8 in.	Lin.ft.	1	6.00	4.00	5.33	150
Changing pneum. postal tel. tube—2½ in.	Lin.ft.	1	8.00	1.00	3.83	800
Changing pneum. West. Union tube—2½ in.	Lin.ft.	1	10.00	1.00	4.50	1,000
New pneum. postal tel. tubes—2½ in.	Lin.ft.	1	6.00	1.00	2.67	600
New pneum. mail tube—8 in.—straight	Lin.ft.	1	6.00	4.00	5.00	150
New pneum. mail tube—8 in.—curved	Lin.ft.	1	15.00	8.00	11.33	188
New pneum. West Union tube—2½ in.—S. and C.	Lin.ft.	1	6.00	1.00	2.67	600
Changing elec. ducts and conduits	Duct.ft.	6	1.00	.35	.62	286
Changing elec. ducts and cond.—2 in. W. S.	Lin.ft.	2	1.50	.50	1.03	300
Changing elec. ducts and cond.—2½ in. W. S.	Lin.ft.	4	5.00	.40	1.62	1,250
Changing elec. ducts and cond.—3 in. W. S.	Lin.ft.	4	6.00	.40	1.81	1,500
Changing elec. ducts and cond.—3½ in. W. S.	Lin.ft.	4	7.00	.60	2.18	1,167
Changing elec. ducts and cond.—4 in. W. S.	Lin.ft.	1	3.00	1.50	2.00	200
Changing elec. ducts and cond.—4½ in. W. S.	Lin.ft.	2	3.00	.60	1.79	500
Changing Edison conduit—2 in. W. S.	Lin.ft.	1	3.00	1.00	1.83	300
Changing Edison conduit—2½ in. W. S.	Lin.ft.	1	3.75	1.25	2.33	300
Changing Edison conduit—3 in. W. S.	Lin.ft.	1	4.00	1.50	2.92	256
Changing Edison conduit—3½ in. W. S.	Lin.ft.	1	4.50	1.75	3.50	257
Service connections for elec. ducts	Each	5	150.00	30.00	55.80	500
Changing wooden elec. ducts and cond.	Duct.ft.	1	.90	.40	.60	225
Changing fibre elec. ducts and cond.	Duct.ft.	3	1.00	.40	.72	250
Changing fibre elec. ducts and cond.—3 in.	Lin.ft.	2	2.00	.35	.86	573
Changing fibre elec. ducts and cond.—3½ in.	Lin.ft.	2	2.00	.40	1.02	500
Changing fibre elec. ducts and cond.—4 in.	Lin.ft.	2	3.00	.45	1.26	667
Service boxes on relocated duct lines	Each	2	250.00	36.00	131.00	694
Junction boxes on relocated duct lines	Each	2	500.00	240.00	348.33	208
Junction boxes—additional	Each	2	840.00	300.00	473.33	280

Weekly Construction Market

CONCURRENT with the arrival of German steel in Galveston, Tex., is the influx of Belgian building brick at the Port of New York.

In the case of bars re-rolled from rails, the price at Dallas sagged, in one week, to the present level of $2.80 per 100 lb. as against $3.08 formerly. The sales were made on a direct-to-consumer basis. Limited shipments of foreign structural shapes also affected the market, probably causing the drop of 15c. per 100 lb. reported in that classification.

Belgian brick, however, did not have the effect of breaking the market. Prices still range from $19 to $20 per M., delivered at site of job in Manhattan. Scarcity, in the presence of heavy demand, probably accounts for the display of price strength in this market.

Domestic producers have recently been troubled with strikes in which the workers won their demands in most cases.

Imports of common brick into the customs district of New York, according to the Bureau of Foreign and Domestic Commerce, were 44,208,000 for the calendar year 1924, against 61,506,000 during 1923.

Inquiries sent out by *Engineering News-Record* to various points along the Atlantic seaboard and West as far as the Mississippi River, showed that the imported brick did not penetrate very far in any direction from New York.

Last year Belgium shipped 43 per cent of the brick received here from Europe; Germany, 39 per cent; Holland, 14 per cent, and Canada, 2 per cent. The rest came from Italy, England, Mexico and Spain.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb	$3.34	$3.90	—$4.00	$3.10	$3.35	$3.07½	$3.30	$3.35	$4.25
Structural rivets, 100 lb	4.50	4.45	4.75	3.50	3.75	4.65	5.00	3.75	6.00
Reinforcing bars, ¾ in. up, 100 lb	3.24	3.40	3.38	—2.60@3.00	3.25	3.62½	3.35	3.25	2.30
Steel pipe, black, 3½ to 6 in. lap, discount	48%	53.2%	—45%	56½%	54.25%	36%	39.2@51%	50%	59.49
Cast-iron pipe, 6 in. and over, ton	50.60@51.60	54.00	—54.00	47.70@48.20	53.00	62.00	52.00	53.00	55.00
Concreting Material									
Cement without bags, bbl	2.50@2.60	2.40	2.05	2.20	2.42	2.84	2.31	2.65	1.80
Gravel, ¾ in., cu.yd	1.75	1.90	2.38	2.75	1.65	1.90	2.15	1.50	1.25
Sand, cu.yd	1.00	1.40	2.00	2.75	1.25	1.00	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd	1.85	2.00	2.83	2.75	1.75	2.50	2.15	3.00	1.90
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	59.00	34.00	56.00	29.00@39.00	38.75	36.25	27.00	23.00	60.00
Lime, finishing, hydrated, ton	18.20	22.50	20.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl	2.50@2.75	1.45	1.85	1.21	1.35	2.70	1.60	2.80	9.50
Common brick, delivered, 1,000	19@20	10.50	12.10	12.00	—13.50	12.00	15.00	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	.0888	.10	.06	.....	.085	.....	.10	.12
Hollow partition tile 4x12x12, per block	.1162	.0888	.10	.06	.07	.085	.108	.10	.10
Linseed oil, raw, 5 bbl. lots, gal	—1.07	—1.13	1.30	1.23	—1.15	+1.31	1.14	1.12	1.25
Common Labor									
Common labor, union, hour	.75	.30	.....	.87½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	.30@.50	.75	.50@.55	.35@.50	.50	.50	.25@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Labor—Concrete laborers' rate, 93¾c.; building laborers, 75c.; excavating laborers, 50c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.60 for Sheboygan. Common labor not organized.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of June 4, the next on July 2.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at par). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3½-in., $59.49.

Car Loadings Portend Gain, Etc.

(*Concluded from p. 1081*)

an increase over the previous two years. Our esimate necessarily deals not with the tonnage to be moved but with the carloads to be handled and with that as a basis we believe our figures are conservative."

On June 1, 1925

E. N.-R. Construction Cost Index Number 204.60

E. N.-R. Construction Volume Index Number 209

For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month